4. ENVIRONMENTAL CONSEQUENCES

Chapter 4 presents the environmental impacts and consequences associated with implementing each alternative for the proposed action. The proposed action is the construction of a facility to treat legacy TRU waste stored at ORNL, followed by disposal at the Waste Isolation Pilot Plant, a facility designated in the Record of Decision for the *Waste Isolation Pilot Plant Disposal Phase Supplemental Environmental Impact Statement* (WM SEIS-II). Disposal of low-level waste is consistent with the Nevada Test Site selected in the *Record of Decision for the Department of Energy's Waste Management Program: Treatment and Disposal of Low-level and Mixed Low-level Waste; Amendment of the Record of Decision for the Nevada Test Site* (DOE 2000). The Low-Temperature Drying Alternative, which involves waste stabilization and volume reduction through treatment by a low-temperature drying process for tank sludge and supernate, and sorting and compaction for the solid waste, is the preferred alternative.

The Low-Temperature Drying Alternative is the preferred alternative based on both the results of the procurement process for treatment of TRU waste and the impacts analysis presented in this EIS. DOE selected the low-temperature drying proposal during the procurement process as the preferred technology based on a combination of environmental and cost considerations. The analysis in this Chapter indicates that the Low-Temperature Drying Alternative would have lower waste volumes, less utility usage, fewer transportation shipments, and lower associated transportation risks than the other action alternatives. Emissions from this alternative would be minor during treatment operations. Waste treatment would result in a reduction in risk in Melton Valley at ORNL due to the treatment of the TRU wastes stored in the SWSA 5 North trenches, which currently release contaminants into the environment, and the threat of accidental release of liquid wastes from the Melton Valley Storage Tanks.

The methods used to determine the impacts and consequences are discussed at the beginning of each resource area. The assumptions and factors used in the analysis and prediction of the impacts are discussed for each resource area and in the appendices. The impacts or consequences for the No Action Alternative and each action alternative are then described. In addition, a comparison of the impacts of the alternatives is presented for each resource area. A summary of the environmental impacts for all of the alternatives is found at the end of Chapter 2.

DOE assumed, for purposes of analysis, 100 years of institutional control, after which there would be a loss of institutional control. Because waste would be treated under the Treatment and Waste Storage at ORNL Alternative, impacts after loss of institutional control would be bounded by the impacts after loss of institutional control under the No Action Alternative.

4.1 LAND USE IMPACTS

This section discusses the impacts of the alternatives on land use and land use classification, and aesthetic and scenic resources in the nearby areas.

4.1.1 Methodology

Methods used to determine the environmental impacts for each of the alternatives on land use are listed below.

- Compared the facility footprint including any shielding requirement (in hectares and acreage) for each alternative.
- Determined if a change to the existing land use classification is required due to the implementation of an alternative.
- Identified changes to the scenic and aesthetic resources of the area.

4.1.2 No Action Alternative

The No Action Alternative would result in no change to the existing land or land use classification during the assumed 100-year institutional control period. The Melton Valley Storage Tanks would continue to store liquid and sludge waste, and the existing solid waste storage facilities would continue to store contact-handled and remote-handled TRU solids. Retrievable TRU and alpha low-level wastes would continue to be stored in the trenches in SWSA 5 North. Scenic and aesthetic resources in the area would remain unchanged.

For purposes of analysis, DOE has also evaluated potential impacts after loss of institutional control. After loss of institutional control, containment for the Melton Valley Storage Tanks, the storage bunkers and trenches, and metal buildings at SWSA 5 North is assumed to fail, releasing radiological and chemical contaminants into the environment. Such releases would permanently commit land near both the Melton Valley Storage Tanks and SWSA 5 North areas to waste storage.

4.1.3 Low-Temperature Drying Alternative

The Low-Temperature Drying Alternative would result in land use impacts, compared to no land use impacts for the No Action Alternative. About 2 ha (5 acres) of land west and adjacent to the Melton Valley Storage Tanks would be altered from forest to direct industrial use due to the construction of the proposed waste treatment facility. The site would be revegetated after D&D of the facility.

The proposed facility site has been designated for industrial land use. The construction, operation, and D&D of the facility would require no change to the overall land use classification for the area.

The proposed site is isolated from the main plant area at ORNL and is not visible to the general public; however, 2 ha (5 acres) of forest would be cleared, impacting the scenic resources in the immediate area. The construction, operation, and D&D activities would be visible to workers at the site and to personnel traveling the Old Melton Valley Road (High Flux Isotope Reactor access road), which would become the main road to the proposed treatment facility.

4.1.4 Vitrification Alternative

The Vitrification Alternative would result in land use impacts, compared to no land use impacts for the No Action Alternative. Approximately 2.8 ha (7 acres) of land west and adjacent to the Melton Valley Storage Tanks would be altered from forest to direct industrial use due to the construction of a vitrification waste treatment facility. The site would be revegetated after D&D of the facility. The proposed facility site has been designated for industrial land use. The construction, operation, and D&D of the facility would require no change to the overall land use classification for the area.

The proposed site is isolated from the main plant area at ORNL and is not visible to the general public; however, about 2.8 ha (7 acres) of forest would be cleared, impacting the scenic resources in the immediate area. The construction, operation, and D&D activities would be visible to workers at the site and to personnel traveling the Old Melton Valley Road, which would become the main road to the proposed treatment facility.

4.1.5 Cementation Alternative

The Cementation Alternative would result in land use impacts, compared to no land use impacts for the No Action Alternative. About 2 ha (5 acres) of land west and adjacent to the Melton Valley Storage Tanks would be altered from forest to direct industrial use due to the construction of a cementation waste treatment facility. The site would be revegetated after D&D of the facility.

The proposed facility site has been designated for industrial land use. The construction, operation, and D&D of the facility would require no change to the overall land use classification for the area.

The proposed site is isolated from the main plant area at ORNL and is not visible to the general public; however, 2 ha (5 acres) of forested land would be cleared, impacting the scenic resources in the immediate area. The cementation waste treatment facility would be visible to workers at the site and to personnel traveling the Old Melton Valley Road during construction, operation, and D&D activities.

4.1.6 Treatment and Waste Storage at ORNL Alternative

This alternative would result in land use impacts, as compared to no land use impacts for the No Action Alternative. About 2 to 2.8 ha (5 to 7 acres) of land west and adjacent to the Melton Valley Storage Tanks would be altered from forest to direct industrial use for the construction of a waste treatment facility (either low-temperature drying, vitrification, or cementation treatment facility). In addition, waste storage facilities would be required to store the treated wastes, further impacting the land. Based on the assumption that the existing solid waste storage facilities (Buildings 7572, 7574, 7842, 7878, and 7879 for contact-handled waste, and Buildings 7855 and 7883 for remote-handled waste) could be used for storage of the treated wastes, an additional 0.3 to 0.8 ha (0.75 to 2 acres) of land would still be required for the construction of additional waste storage facilities, depending on the treatment method selected. The land required for storage of treated waste onsite by the treatment alternatives would be: 0.3 ha (0.75 acres) for treatment by low-temperature drying, 0.6 ha (1.5 acres) for treatment by vitrification, and 0.8 ha (2 acres) for treatment by cementation.

The proposed facility site and storage areas have been designated for industrial land use. The construction, operation, and D&D of the treatment facility, and the construction of waste storage facilities, would require no change to the overall land use classification for the area.

The proposed site is isolated from ORNL's main plant area and not visible to the general public; however, 2 to 2.8 ha (5 to 7 acres) of forested land would be cleared for the waste treatment facility, and an additional 0.3 to 0.8 ha (0.75 to 2 acres) of land would be required for the construction of waste storage facilities, thus impacting the scenic resources in the immediate area. The waste treatment facility would be visible to workers at the site and to personnel traveling the Old Melton Valley Road during construction, operation, and D&D activities. The waste storage facilities would continue to be visible to workers in the area for an indefinite period of time.

4.1.7 Land Use Impacts Summary

There would be no change in land use with the implementation of the No Action Alternative. By comparison, approximately 2 to 2.8 ha (5 to 7 acres) of currently forested land would be developed for a waste treatment facility if any of the alternatives that include waste treatment are implemented. An additional 0.3 to 0.8 ha (0.75 to 2 acres) of land would be required for the construction of waste storage facilities if the Treatment and Waste Storage at ORNL Alternative is implemented.

There would be no change in the current land use classification resulting from the implementation of any of the alternatives; the land, currently classified as industrial, would remain industrial.

The No Action Alternative would result in no change to the existing scenic resources. If a treatment alternative is chosen, the scenic resources of the area would be impacted by the clearing of the currently forested land.

4.2 CULTURAL AND HISTORIC RESOURCES

This section discusses potential impacts to the cultural or historic resources in the area, which includes the Jenkins Site and the Jones Site described in Chapter 3, Section 3.2. The Jenkins Site, located east of the proposed TRU Waste Treatment Facility site, is a pre-1942 homestead site consisting of a deteriorated house and outbuilding (Figure 3-1). A late 1980s evaluation of its eligibility for listing as a historic place by the University of Tennessee concluded that the site was not eligible for listing on the National Register of Historic Places (Campbell et al. 1989). The Jones Site, located east of the proposed TRU Waste Treatment Facility site, dates from 1820 and was recommended for inclusion on the National Historic Register (Campbell et al. 1989). DOE consulted with the Tennessee State Historic Preservation Officer under the provisions of the National Historic Preservation Act regarding any potential adverse consequences associated with the proposed action and the alternatives. The Deputy State Historic Preservation Officer concluded that no properties eligible for the National Register of Historic Places would be affected and had no objections to the TRU Waste Treatment Facility (Appendix E).

4.2.1 Methodology

Impacts to cultural and historic resources were assessed by determining where activities would occur for each of the alternatives. Potential impacts, such as destruction of resources by bulldozing and other site preparation activities, were identified by determining if sensitive resources were present in the area to be disturbed. This presence/absence of cultural and historic resources is based on several reconnaissance-level (walk-down) surveys conducted from 1988 through 1996 (Faulkner 1988; Duvall, 1992, 1993, and 1996) on and near the sites included in each alternative.

4.2.2 No Action Alternative

No archeological, cultural, or historical resources have been identified immediately next to the Melton Valley Storage Tanks, or the legacy TRU solid waste storage facilities. In addition, the

No Action Alternative would have no impact on the historic resources identified in the general area, i.e., the Jones Site and Jenkins Site.

4.2.3 Low-Temperature Drying Alternative

The proposed 2-ha (5-acre) site for a low-temperature drying waste treatment facility has no known archaeological, cultural, or historical resources within or contiguous to its boundaries; thus, no impacts are expected. It is conceivable that surface or subsurface resources may be identified during construction activities, such as the use of heavy equipment for land clearing, grading, and other construction-related work. Appropriate measures such as avoidance, where possible, or data recovery operations, including detailed recording of surface features and/or archaeological excavation, would be implemented to mitigate any identified effects on these resources. The Low-Temperature Drying Alternative would not impact the Jones and Jenkins Sites.

4.2.4 Vitrification Alternative

The proposed 2.8-ha (7-acre) site for a vitrification waste treatment facility has no known archaeological, cultural, or historical resources within or contiguous to its boundaries; thus, no impacts are expected. It is possible that surface or subsurface resources may be identified during construction activities, and appropriate measures such as avoidance, where possible, or data recovery operations, including detailed recording of surface features and/or archaeological excavation, would be implemented to mitigate any identified effects on these resources. The Vitrification Alternative would not impact the Jones and Jenkins Sites.

4.2.5 Cementation Alternative

The proposed 2-ha (5-acre) site for a cementation waste treatment facility has no known archaeological, cultural, or historical resources within or contiguous to its boundaries; thus, no impacts are expected. It is conceivable that surface or subsurface resources may be identified during construction activities, such as the use of heavy equipment for land clearing, grading, and other construction-related work. Appropriate measures such as avoidance, where possible, or data recovery operations, including detailed recording of surface features and/or archaeological excavation, would be implemented to mitigate any identified effects on these resources. The Cementation Alternative would not impact the Jones and Jenkins Sites.

4.2.6 Treatment and Waste Storage at ORNL Alternative

The proposed 2- to 2.8-ha (5- to 7-acre) site for the waste treatment facility, and the 0.3- to 0.8-ha (0.75- to 2-acre) area needed for the waste storage facilities required for the implementation of this alternative, have no known archaeological, cultural, or historical resources within or contiguous to its boundaries; thus, no impacts are expected. It is conceivable that surface or subsurface resources may be identified during construction activities, such as the use of heavy equipment for land clearing, grading, and other construction-related work. Appropriate measures such as avoidance, where possible, or data recovery operations, including detailed recording of surface features and/or archaeological excavation, would be implemented to mitigate any identified effects on these resources. The Treatment and Waste Storage at ORNL Alternative would not impact the Jones and Jenkins Sites.

4.2.7 Cultural and Historic Resource Impacts Summary

There are no known archaeological or cultural resources within the area of the proposed site. None of the alternatives would impact any properties registered, or eligible for registration, in the National

Register of Historic Places. The alternatives that include waste treatment would take appropriate measures (avoidance, data recovery, etc.) if any surface or subsurface archeological, cultural, or historic resources were detected during construction, operation, or D&D of the proposed treatment facility.

4.3 ECOLOGICAL RESOURCES

This section discusses impacts to the ecological resources of the area, including flora and fauna, that would result from the implementation of each of the alternatives. Field surveys conducted in the summer of 1999 (Appendices C.2 and C.3) indicated that there were no Federal or Tennessee State-listed sensitive plant species, aquatic resources, or threatened or endangered animal species identified on the proposed facility site. In addition, DOE also consulted with the U.S. Fish and Wildlife Service and the TDEC (Appendix E) regarding the potential presence of Federally- or State-listed threatened or endangered species on or near the proposed TRU Waste Treatment Facility. The U.S. Fish and Wildlife Service indicated that the gray bat and pink mucket pearly mussel (both Federally-listed endangered species) are known to occur near the project area, and that potential habitat for the Indiana bat (Federally-listed endangered) might be present near the project area. DOE also prepared a draft Biological Assessment for those three species (Appendix E).

Although the pink mucket pearly mussel is known to occur in the Clinch River in Tennessee, the species is unlikely to be present in Melton Branch, White Oak Creek, or White Oak Lake near the proposed facility because these bodies of water do not provide proper habitat. Because there is no suitable habitat for this species present on or near the proposed site, there would be no direct or indirect impacts to the pink mucket pearly mussel.

The nearest potential roosting habitat (cave) for the gray bat is at least a mile away from the proposed TRU Waste Treatment Facility boundary. Because the gray bats generally feed near water, and the caves that are approximately 4 miles of the proposed TRU Waste Treatment Facility are close to streams, the gray bats would not be dependent on habitat at the proposed site for feeding (Appendix E). Although the proposed TRU Waste Treatment Facility could potentially contain suitable trees for summer nesting by the Indiana bat, any potential adverse impacts to the species during nesting would be avoided by making sure not to cut any trees onsite during May–September.

Thus, as a result of the field surveys from 1999, consultations with U.S. Fish and Wildlife Service, and evaluation of the habitat requirements for the gray bat and pink mucket pearly mussel, no direct or indirect adverse impacts to sensitive plant species, aquatic biota (including the pink mucket pearly mussel), gray bats, or wildlife species In Need of Management are expected.

Woodland habitats are present on knolls, ridges, and more upland areas. Several types of woodlands, such as deciduous oak-hickory, or transitional woodlands with a mixture of deciduous and pines, would be suitable for sensitive terrestrial animal species. The trees on the proposed site are young to mid-aged with diameter at breast height mostly under 1.5 ft, which is consistent with the size requirements for maternity trees for the Indiana bat. However, no hollow trees, dead or alive, were observed on the site.

4.3.1 Methodology

Methods used to determine impacts from the implementation of the proposed action are listed below.

- Quantified changes to the environment, such as the destruction of vegetation and wildlife habitat associated with construction of any facilities.
- Conducted field surveys to determine the presence or absence of sensitive animal (Appendix C.2) and plant species (Appendix C.3), and consulted with appropriate agencies.
- Determined the potential impact of process and sanitary wastewater discharges to the area's biota. The effects to biota from fugitive dust are discussed in Section 4.5.1.3.
- Qualitatively discussed changes to the environment due to human activities, such as traffic and noise.

4.3.2 No Action Alternative

During institutional control, the implementation of the No Action Alternative would include long-term continued storage of TRU wastes in their present locations and would not result in the clearing of any land, nor loss of habitat. The No Action Alternative would continue to impact terrestrial plant, animal, and aquatic species in the SWSA 5 North trench area, as the site would continue to exist in the present state. TRU and alpha low-level wastes currently stored in the below-grade trenches at SWSA 5 North are a source of radionuclide contamination to soils, groundwater, surface water, and the biota. This contamination source would continue if this alternative were implemented.

Potential impacts to aquatic biota and fish over the next 10,000 years due to loss of institutional control could come from release of radionuclides and non-radionuclides from sources such as the Melton Valley Storage Tanks, as well as trenches and buildings at the SWSA 5 North area, etc. These potential impacts were evaluated semi-quantitatively for a scenario in which the Melton Valley Storage Tanks leak gradually into White Oak Lake, and qualitatively for releases from all other sources. For the Melton Valley Storage Tanks, it was assumed that the tanks all leak at a constant rate of 1% of their volume per year. Therefore, the entire liquid contents of the tanks are assumed to be transferred to White Oak Lake over a period of 100 years.

To estimate exposure in White Oak Lake from the Melton Valley Storage Tanks, it was assumed that the concentration of radionuclides would reach steady-state when the radionuclide activity leaking into the lake was the same as the rate of loss from the lake. The daily leakage rate was calculated by multiplying the assumed volume of 50,000 gal per tank by 8 tanks and 3.78 L/gal. The total volume was multiplied by 1% per year and divided by 365.25 days/year, resulting in a leakage rate or flow (designated F_{tank}) of 41 L/day. The average concentration (designated C_{tank}) of each radionuclide in the tanks was calculated using analytical data from the tanks (Keller et al. 1996). Rapid mixing into White Oak Lake was assumed. It was assumed that the flow from White Oak Lake (designated F_{lake}) is 1.3×10^6 ft^3/d = 4.6×10^{10} L/d (Loar 1992). At steady-state, the mass entering the lake ($C_{tank} \times F_{tank}$) equals the mass leaving the lake ($C_{lake} \times F_{lake}$). Therefore,

$$C_{lake} = C_{tank} \times F_{tank}/F_{lake} = 41/4.6\times10^{10} = C_{tank} \times 9.02 \times 10^{-10}.$$

Average concentrations of radionuclides in the tanks and steady-state concentrations are shown below:

Radionuclide	Average tank concentration (C_{tank})Bq/mL	Steady-state lake concentration (C_{lake})Bq/mL
Cesium-134	1.93E+04	1.74E-05
Cesium-137	8.13E+05	7.34E-04
Cobalt-60	1.15E+03	1.03E-06
Europium-152	4.13E+02	3.73E-07
Europium-154	2.98E+02	2.69E-07
Europium-155	1.28E+03	1.66E-06
Iodine-129	1.19E-01	1.08E-10
Plutonium-238	1.40E+00	1.26E-09
Plutonium-239/240	1.09E+00	9.80E-10
Plutonium-242	5.23E-01	4.72E-10
Strontium-90	4.87E+04	4.40E-05
Technetium-99	7.70E+02	6.95E-07
Uranium-233	1.54E+01	1.39E-08
Uranium-234	1.00E-01	9.02E-11
Uranium-235	1.00E-01	9.02E-11
Uranium-236	1.00E-01	9.02E-11
Uranium-238	5.00E-01	4.51E-10

The steady-state concentrations of all radionuclides were compared to benchmarks for aquatic biota (Bechtel Jacobs 1998) by dividing the concentration by the benchmark to calculate hazard quotients. The benchmarks correspond to the widely used National Council on Radiation Protection and Measurements recommended limit of 1 rad/day for aquatic organisms. Radiation hazards to herons were calculated for internal radiation as a result of ingesting water and fish and for external radiation from water. Methods are described in Appendix F.2 and are similar to those described by Bechtel Jacobs (1998).

The sum of hazard quotients for aquatic biota at steady-state was 7.0×10^{-7}, indicating that there would be no hazard to aquatic populations from leakage of the Melton Valley Storage Tanks at the assumed rate. The sum of hazard quotients for herons was 1×10^{-6}, indicating no hazard to fish-eating predators. Note that the assumed exposures do not take into account possible accumulation of some radionuclides in sediment. They also are conservative because they do not account for loss of activity by radioactive decay. For example, the half-life of cobalt-60 is 5.27 years, so in 100 years, the activity of cobalt-60 would have decreased from 1.03×10^{-6} Bq/mL to 2×10^{-12} Bq/mL, and the average exposure over 100 years would be approximately 700-fold less than the estimated exposure. Similarly, cesium-134, cesium-137, strontium-90, europium-154, and europium-155 would all have decayed substantially. Europium-152 would almost all have been converted to gadolinium-152, an alpha emitter with a long half-life. Therefore, assuming immediate leakage of the tanks as described above provides the largest possible exposure. Thus, the negligible hazard to biota from leakage from the Melton Valley Storage Tanks during the first 100 years after loss of institutional control would only continue to decrease during the remainder of the 10,000 years.

Although releases from the Melton Valley Storage Tanks do not appear to pose adverse impacts of aquatic biota during the next 10,000 years under the assumptions described above, potential risks to biota as described in the Remedial Investigation Report on the Melton Valley Watershed (DOE 1997a) are likely to continue and possibly increase due to larger uncontrolled releases from the SWSA 5 North trenches and other upstream sources.

4.3.3 Low-Temperature Drying Alternative

The clearing of trees and vegetation in preparation of the 2-ha (5-acre) site for facility construction would impact the area habitats. The habitat is young to mid-successional forest. The area of proposed disturbance is small in relation to the surrounding similar habitat, 2 ha (5 acres) in comparison to 14,569 ha (36,000 acres) included in the ORR; therefore, impacts on terrestrial plant and animal species habitat are expected to be small. The most affected animal species are small vertebrates such as mice and amphibians, which have home ranges less than 2 ha (5 acres); thus, clearing this land would result in complete loss of their habitat.

The proposed facility site contains few aquatic biota (except for some aquatic invertebrates, such as insects or worms, as well as aquatic microorganisms such as algae and diatoms) because there is so little permanent aquatic habitat onsite. Streams downstream from the proposed facility site, such as Melton Branch and White Oak Creek, as well as White Oak Lake, contain larger numbers and variety of aquatic organisms due to better habitat. The proposed low-temperature drying facility would not treat or release wastewater; thus, there would be no impact to the area's aquatic biota from wastewater discharges. In addition, treatment of the waste in the SWSA 5 North trenches would positively impact terrestrial and aquatic biota in this area when the contamination sources from these trenches is removed.

In addition to the loss of habitat, construction noise and increased area activity would cause temporary displacement of local wildlife populations. These wildlife populations are expected to return once activities are completed at the proposed site. Estimated impacts outside of the fenced facility area are expected to be minimal because of restricted employee access and limited anticipated activities outside the defined facility area. Impacts resulting from increased vehicular traffic could be represented by small animal displacement, instances of road kills, and a shift in vegetation composition to more disturbance-tolerant species. These impacts would be primarily associated with increased vehicular traffic on the Old Melton Valley Road.

Impacts resulting from the D&D of the facility would be very similar, although less intense, to the early clearing, construction, and operation of the proposed treatment facility. Site cleanup, breakdown of equipment, dismantling of the facility, and final waste transportation out of the area are activities that would be expected during the D&D project phase. After completion of the D&D activities, the site would be revegetated, in order to re-establish animal and plant species.

4.3.4 Vitrification Alternative

The clearing of trees and vegetation in preparation of the 2.8-ha (7-acre) site for facility construction would impact area habitats. The construction, operation, and D&D of the proposed treatment facility, and increased human presence, would also result in impacts from the implementation of this alternative. These anticipated impacts would be similar to the impacts discussed for the Low-Temperature Drying Alternative. An additional 0.8 ha (2 acres) of land would be disturbed, since this alternative requires a slightly larger facility area than the other alternatives.

Because the facility would not treat or release process or sanitary wastewater, the aquatic biota would not be impacted by wastewater discharges. Steam may be a byproduct of the vitrification process but, due to placement of engineering controls within the treatment system, harmful contaminants should be extracted from the steam; thus, there are no anticipated impacts from temperature changes in the surrounding area due to the release of steam or heat from the facility. Correct implementation of treatment procedures would not result in any additional measurable impacts to terrestrial flora or fauna of the area. The treatment of the waste in the SWSA 5 North trenches would positively impact terrestrial and aquatic biota in this area when the contamination sources from the trenches is removed. Air emissions such as fugitive dust are discussed in Section 4.5.

Following closure and D&D of the vitrification facility, the site would be revegetated in order to reestablish animal and plant species.

4.3.5 Cementation Alternative

The clearing of trees and vegetation in preparation of the 2-ha (5-acres) site for facility construction would impact the area habitats. The anticipated impacts resulting from the implementation of the Cementation Alternative would include impacts associated with clearing of the proposed site, construction of the treatment facility, and increased human presence, which are similar to those impacts discussed for the Low-Temperature Drying Alternative.

The Cementation Alternative would not treat or release process or sanitary wastewater, and no waste discharge resulting from waste treatment is expected; thus, aquatic biota would not be impacted from wastewater discharge. The treatment of the waste in the SWSA 5 North trenches would positively impact terrestrial and aquatic biota in this area when the contamination sources from the trenches is removed. Air emissions such as fugitive dust are discussed in Section 4.5.

Following closure and D&D of the cementation facility, the site would be revegetated in order to reestablish animal and plant species.

4.3.6 Treatment and Waste Storage at ORNL Alternative

The impacts resulting from implementation of this alternative are associated with clearing the proposed site, construction of the proposed treatment facility and waste storage units, and increased human presence, as discussed previously for the three alternatives that involve waste treatment (low-temperature drying, vitrification, and cementation). A total of 0.3 to 0.8 ha (0.75 to 2 acres) of habitat would be lost due to the construction of the additional and waste storage facilities. These new facilities would be located adjacent to the Melton Valley Storage Tanks storage area (see Figure 2-4) and at SWSA 5 North.

The additional waste storage facilities would be required for the treated wastes, because under this alternative the treated wastes would continue to be stored at ORNL rather than shipped to an off-site disposal facility. It is assumed for analyses purposes that the existing storage facilities for contact-handled and remote-handled TRU waste would be the storage location of some of the treated wastes; however, additional land would be required for the construction of waste storage facilities, the size of which is dependent on the type of treatment selected. An additional 0.3 ha (0.75 acre) of land would be required for the Low-Temperature Drying Alternative, and 0.6 ha (1.5 acres) would be required for the Vitrification Alternative. The Cementation Alternative would require an additional 0.8 ha (2.0 acres) of land for waste storage. This land is relatively low-quality habitat consisting of cleared industrial areas for the existing waste storage facilities or wooded areas adjacent to the existing cleared storage sites. This habitat would be permanently lost to the flora and fauna that currently use it.

After loss of institutional control, waste constituents would eventually be released into the environment. While impacts to biota are bounded by the No Action Alternative, impacts are expected to be less severe for this alternative because wastes are treated and better contained.

4.3.7 Ecological Impacts Summary

Impacts to terrestrial and aquatic biota due to the continued storage of TRU and alpha low-level wastes in the below-grade trenches in SWSA 5 North would continue under the No Action Alternative.

The four action alternatives would result in this waste being treated and the primary source of contamination in SWSA 5 North would be removed.

The No Action Alternative would not involve the clearing of any land or loss of habitat; however, over the long term after loss of institutional control, the wastes would eventually be released into the environment and would pose a threat to biota. Alternatives that include waste treatment would involve the construction of a single, compact process building affecting approximately 2 to 2.8 ha (5 to 7 acres) of young to mid-successional forested habitat, depending on the treatment selected. The Treatment and Waste Storage at ORNL Alternative would require an additional 0.3 to 0.8 ha of land (0.75 to 2 acres) for the construction of storage facilities needed to implement this alternative. Some construction-related wildlife displacement would be likely, and there is a potential for an increase in road kills during the construction, operations, and D&D activities.

There have been no sensitive plant species, either Federal- or State-listed, identified to occur exclusively in the proposed site area. Therefore, the land clearing and increased area activity that would result from implementation of the four alternatives that include waste treatment would not result in the loss of compatible habitat for any listed plant species. No threatened or endangered species, either State or Federal, were identified at the proposed site during a survey conducted in the summer of 1999. No impacts to threatened and endangered species or aquatic biota are expected from the implementation of any of the treatment alternatives.

4.4 GEOLOGY AND SEISMICITY IMPACTS

The potential impacts to geology and seismicity were analyzed for each alternative for the proposed TRU Waste Treatment Facility.

4.4.1 Methodology

Methods used to determine the environmental impacts for each alternative are listed below.

- Identified activities that could affect near-surface geology (pile driving, blasting, etc.) or deep geology.
- Identified major load-bearing structures that could potentially affect geologic faults.
- Identified the seismic zone for the proposed facility location and required building requirements.
- Quantified the amount of soil disturbed.

4.4.2 No Action Alternative

There would be no construction under the No Action Alternative; therefore, no soils would be disturbed. However, impacts from the ongoing release of contaminants into soils would continue.

The waste stored in the SWSA 5 North trenches would continue to be a source of primary contamination to soils and secondary contamination to soils and groundwater in the SWSA 5 North area. Approximately 14,000 curies of radiation is estimated in the waste contained in these trenches.

The TRU and alpha low-level waste contained in the trenches is stored in 4-inch-thick concrete casks, or a combination of wood and metal boxes. Radioactive contaminants have been identified in the soil and groundwater in SWSA 5 North, and over the 100-year life of this alternative, the waste would continue to impact the soils in this area.

The TRU waste currently stored in the Melton Valley Storage Tanks, and the various storage buildings and bunkers, poses little threat to the site soils or geology during the institutional control period. The nature of the sludge and supernate waste currently contained within the Melton Valley Storage Tanks, and the 0.5-inch-thick stainless steel construction of these tanks, suggest a breach in tank integrity is unlikely in the near future. Likewise, the materials stored in the various buildings and bunkers are primarily solids, and although the individual containment vessels (drums, rolloff boxes, etc.) lack the overall integrity of the Melton Valley Storage Tanks, a release is not expected during this time.

The No Action Alternative would not affect geologic faults or regional seismicity, as there would be no construction.

After loss of institutional control, not only would releases continue from the SWSA 5 North trenches, but the wastes in the buildings and bunkers at SWSA 5 North would be released due to containment failure (building and bunker collapse and drum and cask failures) and would contaminate the soil, surface water, and groundwater. Eventually, the wastes in all eight Melton Valley Storage Tanks would be released via some form of tank failure. These wastes would also contaminate the soils near the tanks, assuming that failure of a single tank results in 0.55 ha of land being contaminated (Appendix F). While it is not possible to reliably predict if all tanks would fail at once or would be spread out over a period of many years, wastes would contaminate soils over several hectares and would constitute a source of contamination to the environment for many years after release.

4.4.3 Low-Temperature Drying Alternative

The activities associated with the Low-Temperature Drying Alternative proposed facility construction, operation, or D&D activities would be expected to have a small impact on the immediate site area geology and soils. No blasting or pile driving are expected to be required. The proposed facility has been designed to take advantage of the existing topography contours of the site, in order to minimize the amount of cut and fill (less than 22,937 m^3 or 30,000 yd^3) during construction of the proposed facility, based on the facility design discussed in Chapter 2.

No significant removal or addition to the indigenous soils from the site is expected; however, 2 ha (5 acres) would be graded and the soils disturbed during construction of the low-temperature drying waste treatment facility. Further, the removal of the TRU waste from the SWSA 5 North trenches would beneficially impact the area by removing the primary source of contamination to the soils.

Upon competition of the facility D&D activities, the original site contours would be largely restored. The impacts from erosion and other undesirable downhill or downstream effects of storm water runoff are expected to be negligible due to the proposed site layout plan, including passive diversion and hold-up features (see Section 4.5.1.3 for a discussion of soil erosion and dust control). Essentially no change would be made to the current storm water flows, directions, or collection points beyond the boundaries of the facility due to soil disturbance.

The Low-Temperature Drying Alternative would not affect geologic faults or regional seismicity. The proposed facility for the Low-Temperature Drying Alternative is located in Seismic Zone 2, and would be designed with consideration to the Uniform Building Code (UBC) requirements of Seismic Zone 2 facilities. The low-temperature drying waste treatment facility has a projected life of 11 years, and would be designated as a non-reactor nuclear facility as defined in DOE Order 5480.23, which dictates two containment barriers to the release of contamination during waste treatment operations and shielding/confinement for worker protection and contamination control. The facility would be compact, cubic in dimensions, and heavily shielded, all of which facilitate meeting the required standards.

4.4.4 Vitrification Alternative

The activities associated with the vitrification facility construction, operation, or D&D activities would be expected to have a small impact on immediate site geology and soils. No blasting or driving would be required; therefore, on-site activities should not impact the local subsurface materials. However, 2.8 ha (7 acres) would be graded and the soils disturbed during construction of the vitrification waste treatment facility. Erosion impacts are expected to be negligible and are discussed further in Section 4.5.1.4.

The Vitrification Alternative would not affect geologic faults or regional seismicity. Since the proposed facility for the Vitrification Alternative is located in Seismic Zone 2, it would be designed with consideration to the UBC requirements of Seismic Zone 2 facilities. The facility would be designated as a non-reactor nuclear facility as defined in DOE Order 5480.23, which dictates two containment barriers to the release of contamination during waste treatment operations and shielding/confinement for worker protection and contamination control. The facility would be compact, cubic in dimensions, and heavily shielded, all of which facilitate meeting the required standards.

The removal of the TRU waste from the SWSA 5 North trenches would beneficially impact the area by removing the primary source of contamination to the soils. Following completion of the scheduled project D&D activities, the site contours would be largely returned to pre-existing conditions.

4.4.5 Cementation Alternative

The activities associated with the cementation facility construction, operation, or D&D activities would be expected to have a small impact on the immediate site geology and soils. No blasting or pile driving would be required; therefore, on-site activities should not impact the local subsurface materials. However, 2 ha (5 acres) would be graded and the soils disturbed during construction of the cementation waste treatment facility. No significant removal or addition to the indigenous soils from the site is expected.

The Cementation Alternative would not affect geologic faults or regional seismicity. The proposed facility would be located in Seismic Zone 2, and designed with consideration to the UBC requirements of Seismic Zone 2 facilities. The facility would be designated as a non-reactor nuclear facility as defined in DOE Order 5480.23, which dictates two containment barriers to the release of contamination during waste treatment operations and shielding/confinement for worker protection and contamination control. The facility would be compact, cubic in dimensions, and heavily shielded, all of which facilitate meeting the required standards.

Impacts from erosion and other undesirable downhill or downstream effects of storm water runoff are expected to be negligible due to the proposed site layout plan (see further discussion in Section 4.5.1.5). The removal of the TRU waste from the SWSA 5 North trenches would beneficially impact the area by removing the primary source of contamination to the soils. Following completion of the scheduled project D&D activities, the site contours would be largely returned to preexisting conditions.

4.4.6 Treatment and Waste Storage at ORNL Alternative

Small impacts to site geology and soils would be expected with the implementation of the Treatment and Waste Storage at ORNL Alternative. This alternative would involve treatment by low-temperature drying, vitrification, or cementation. These impacts are discussed in the previous sections. Following treatment, the waste would be stored onsite at ORNL in the existing storage facilities for contact-handled and remote-handled TRU waste or new waste storage facilities as required to handle the volume of treated wastes. The new waste storage facilities would require an additional 0.3 to 0.8 ha (0.75 to 2 acres) of land depending on the selected treatment method.

4.4.7 Geology and Seismicity Impacts Summary

None of the alternatives would impact deep or near-surface geology because there would be no blasting or pile driving involved with any of the alternatives. None of the alternatives would impact the regional seismicity. Under the No Action Alternative the waste from the trenches in SWSA 5 North would continue to release radiological contamination to the soils from these unlined trenches. The four action alternatives would treat the waste that is the primary source of soil contamination in the SWSA 5 North area, but some contaminated soils would likely remain in place until addressed under a CERCLA action. Each alternative that includes waste treatment would disturb soils due to construction and demolition activities; however, the impacts are expected to be small because no significant removal or addition of soils at the site is expected and the proposed facility would take advantage of site contours. By comparison, no soil disturbance would occur under the No Action Alternative. However, after the loss of institutional control under No Action, wastes from the Melton Valley Storage Tanks and wastes in the trenches, bunkers, and buildings at SWSA 5 North would contaminate soils.

4.5 WATER AND WATER QUALITY IMPACTS

The impacts to surface water (Section 4.5.1) and groundwater (Section 4.5.2), and wetlands and floodplain resources (Section 4.5.3), were analyzed for all alternatives to the proposed action.

4.5.1 Surface Water Impacts

This section discusses the environmental impacts to the proposed area's surface water resources. Impacts from the construction, operation, and D&D phases of the proposed facilities are discussed, as applicable, for each alternative. Water use is evaluated in the Utility Requirements Impacts, Section 4.9.

4.5.1.1 Surface water impacts methodology

Methods used to determine potential impacts to surface water for each alternative are listed below.

- Determined changes in surface water quality due to runoff or contamination releases.
- Estimated potential sediment loading using the Revised Universal Soil Loss Equation (Toy and Foster 1998).
- Described storm water control and monitoring measures.
- Calculated the amount of sanitary wastewater and process wastewater volumes and compared these volumes to the capacity of the existing wastewater systems expected to process these waste waters.

4.5.1.2 No Action Alternative

Currently, the SWSA 5 North trenches and nearby areas in this watershed sub-basin release 6% of the total measured strontium-90 and 3.6% of the total measured cesium-137 to the surface waters of the Melton Valley Watershed, which is part of the White Oak Creek Watershed [*Remedial Investigation Report on the Melton Valley Watershed at Oak Ridge National Laboratory, Oak Ridge Tennessee, Volume 1,* DOE/OR/02-1546/V1&D2 (DOE 1997a)]. The No Action Alternative would continue to impact the surface waters of White Oak Creek and waters downstream from White Oak Lake due to the continued storage of the waste in the SWSA 5 North trenches, which contain 14,000 curies of activity (including americium-241 and curium-244). If the No Action Alternative were implemented, the rate of long-lived radionuclide release could increase over time potentially affecting downstream waters. The long-lived nature of the radionuclides in the solid waste and their high curie content would result in long-term contamination.

Continued storage of the wastes in the Melton Valley Storage Tanks is not expected to result in a release to the surface waters in Melton Branch, White Oak Creek, White Oak Lake, and the unnamed tributary west of the Melton Valley Storage Tanks under normal operations during institutional control. The existing sludge and supernate inventories are stored in corrosion-resistant 304 SS tanks that have secondary containment provided by 304 SS-lined concrete vaults. The Melton Valley Storage Tanks undergo annual integrity assessments, which are required by RCRA, and must maintain their release detection monitoring capabilities. Results of these annual assessments continue to demonstrate that the Melton Valley Storage Tanks are not releasing hazardous constituents or radionuclides to the environment.

In addition, the No Action Alternative would not generate wastewater. Any wastewater that results from spill clean-ups in the vaults would be managed as mixed wastes, or bottled and transported to the low-level waste evaporator at ORNL. Storm water runoff from the Melton Valley Storage Tanks area would continue to be collected in open channels and storm water culverts and diverted to Melton Branch.

Potential impacts to surface water over the next 10,000 years, after loss of institutional control, could come from the release of radionuclides and non-radionuclides from sources such as the Melton Valley Storage Tanks, as well as trenches and buildings and bunkers at the SWSA 5 North area. These potential impacts were evaluated semi-quantitatively for a scenario in which the Melton Valley Storage Tanks leak gradually into White Oak Lake, and qualitatively for releases from all other sources. For this scenario, it was assumed that the tanks all leak at a constant rate of 1% of their volume per year. Therefore, the entire liquid contents of the tanks are assumed to be transferred to White Oak Lake over a period of 100 years, as previously described in Section 4.3.2. This scenario results in the daily release of only 41 liters of liquid waste per day from the combined tanks, which equates to a steady-state concentration in White Oak Lake that is described by the following equation:

$$C_{lake} = C_{tank} \times F_{tank}/F_{lake} = 41/4.6 \times 10^{10} = C_{tank} \times 9.02 \times 10^{-10}.$$

Average concentrations of radionuclides in the tanks and steady-state concentration were presented in Section 4.3.2. Examination of the non-radionuclide concentrations in the Melton Valley Storage Tanks reveals that their steady-state concentrations would not exceed current State of Tennessee Water Quality Criteria or Federal Ambient Water Quality Criteria. Thus, releases from the Melton Valley Storage Tanks should have negligible adverse impacts to surface water quality.

However, it is likely that most, if not all, of the contents of the SWSA 5 North trenches and buildings and bunkers in this area would be released to the environment during the 10,000 years following the loss of institutional control. Accurate estimation of the impacts to surface water from those sources is difficult because of the uncertainties associated with the nature and rates of the releases. However, there are likely to be releases from SWSA 5 North trenches, at least as much as current levels, and from the bunkers and buildings. These releases would adversely affect water quality. Contaminant releases over time are partially offset by radioactive decay of waste constituents during the 10,000 years after the loss of institutional control.

4.5.1.3 Low-Temperature Drying Alternative

Impacts to White Oak Creek, Melton Branch, and White Oak Lake during the construction period are expected to be negligible because soil erosion and dust control measures would be implemented (silt fences, planting vegetative cover, storm drainage controls, etc.). However, if soil erosion and fugitive dust were not controlled during the construction period, surface water quality (and associated aquatic biota) would be impacted from increased siltation and turbidity. Soil erosion rates are based on the general climatic conditions for eastern Tennessee, the soil types, the length and slope of the construction cut, and the amount of time the soil would be exposed. The Revised Universal Soil Loss Equation (Toy and Foster 1998) estimates approximately 405 metric tonnes/ha/year (181 tons/acre/year) of soil loss in the absence of controls (Appendix F.1 contains the detailed calculations and assumptions used for these data). Normal soil loss for unexposed but similar soils would be at a rate of approximately 6.7 metric tonnes/ha/year (3 tons/acre/year) (Moneymaker 1981). For instance, the clearing of approximately 2 ha (5 acres), and digging the foundation for the low-temperature drying waste treatment facility, could potentially result in soil erosion from wind and specially precipitation runoff.

The unnamed tributary to White Oak Creek that flows along the eastern edge of the proposed facility boundary would likely experience some increased siltation during construction in order to route this tributary through a culvert. Impacts should be minor because the tributary is small with very little actual flow. Soil erosion, especially during rain events, could be deposited onto the floodplains for Melton Branch and White Oak Creek, causing increased short-term siltation and turbidity in the streams and White Oak Lake.

Impacts to Melton Branch, White Oak Creek, and White Oak Lake resulting from the operation of a low-temperature drying waste treatment facility are expected to be negligible for the reasons described below. During operations, the facility would not treat process and sanitary wastewater onsite and no wastewater would be released to surface waters. Sanitary wastewater would be contained and transported by vendors for disposal at an NPDES-permitted wastewater treatment plant. Any excess water that may be generated from the facility would be collected, contained, and transported by tanker truck offsite by vendors for treatment and/or disposal at an appropriate permitted facility. The total amount of sanitary wastewater that would be generated for this alternative is estimated to be 1,560 m^3 (412,000 gal) (Roy 1999). NPDES-permitted wastewater treatment plants that potentially could be used to treat this wastewater include plants located on the ORR (ORNL, Y-12, or ETTP), or those located offsite such as the City of Oak Ridge or the Kingston wastewater treatment plants. These wastewater treatment plants have capacities to treat sanitary wastewater that range from 681,000 m^3/day [180,000,000 gal per day (gpd)] at the ORNL plant, to 22,200 m^3/day (5,870,000 gpd) at the city of Oak Ridge plant. All of these wastewater treatment plants are operating below their design capacities, so the impact of this additional waste stream from the low-temperature drying waste treatment facility would be negligible to the sanitary wastewater systems. Water usage is discussed in Section 4.9.

The treatment of the wastes removed from the SWSA 5 North trenches would have a positive impact on the surface waters of the Melton Valley and White Oak Creek Watersheds by reducing the amount of radionuclides that could be released to the surface waters.

During facility operations, storm water would be controlled and monitored according to the requirements of the facility's storm water permit to minimize any potential impacts. For example, storm water runoff originating outside the facility boundary would be directed either beneath or around the site (Section 2.4.1). Both off-site and on-site storm water would be managed, so the volumes, rate of flow, direction, or final destination of these flows would not significantly be changed. The facilities' paved areas and parking lots would generally drain west to a detention basin, and the basin outlet would drain through a gate valve to a drainage ditch along the main access road to the facility and eventually cross to the north via an existing culvert under the road. The facility roof and eastern edge of the facility's paved area would drain east to a catch basin that is also equipped with a gate valve. This flow would be directed through a culvert under the Old Melton Valley Road to an existing drainage area located on the north side of this road. The storm water flow from this ditch would eventually reach White Oak Creek. Although the storm water falling on the site would travel more quickly to the retention ditches and areas, the design and hold-up capacity for the retention ditches and areas would result in a rate and location of discharge that is comparable to the pre-development characteristics. In the unlikely event of an outdoor spill or leak of hazardous materials, the gate valves would be closed to contain the event during its cleanup. Storm water drainage off the Melton Valley Storage Tanks vault roof would be captured and diverted to an eastern, gated drainage culvert to be installed for the proposed facility.

The impacts to surface water from D&D activities of the proposed facility are expected to be negligible, and generally similar to those discussed for construction and operation activities. No discharges of wastewater would take place during the facility's D&D activities. Mitigation measures to control soil erosion and fugitive dust during D&D activities would be used to minimize the transport of soil to surface water.

4.5.1.4 Vitrification Alternative

The impacts to White Oak Creek, Melton Branch, and White Oak Lake during the construction phase are expected to be negligible because soil erosion and fugitive dust control measures would be implemented (described in Section 4.5.1.3). In the absence of such controls, potential construction-related soil loss is estimated at a rate of 405 metric tonnes/ha/year (181 tons/acre/year) (Appendix F.1), and the impacts would be similar to those described in Section 4.5.1.3.

The impacts to Melton Branch, White Oak Creek, and White Oak Lake from the 3-year operations of the proposed facility are also expected to be negligible. No sanitary wastewater or process wastewater would be discharged directly to the environment. The amount of sanitary wastewater generated over the life of the vitrification facility would be 6,283 m^3 (1.66 million gal). There is a slightly higher probability that contaminants could be released into the environment because of additional treatment of process wastewater for this alternative. Process wastewater would be recycled to the extent possible, but occasional "bleeding" of excess water in the system would be required. The process wastewater that is occasionally drawn off the system would be sent to an evaporator, with the condensate sent to a wastewater treatment facility for discharge into an NPDES-approved outfall. The extra step of sending excess process wastewater to the evaporator slightly increases the risk of releasing contaminants to the environment. The condensate would meet applicable NPDES permit limits, and should not have any adverse impacts to surface water. The concentrate left in the evaporator would be mixed with grout binders to form a stabilized waste form that would have no impacts to the surface water quality.

The removal of the wastes from the SWSA 5 North trenches would have a positive impact on the surface waters of the Melton Valley and White Oak Creek Watersheds by reducing the amount of radionuclides that could be released to the surface waters.

Storm water would be managed similar to the methods discussed previously for the Low-Temperature Drying Alternative. The impacts of treating the additional wastewaters at the chosen wastewater treatment plant should be negligible for the same reasons discussed for the Low-Temperature Drying Alternative.

The impacts to surface water from D&D activities for the Vitrification Alternative are expected to be negligible and generally similar to those discussed for construction and operation phase activities. No discharges of wastewater would take place during the D&D phase, and overall impacts to surface water during the approximate 2-year D&D phase should be negligible.

4.5.1.5 Cementation Alternative

Impacts to the surface waters of White Oak Creek, Melton Branch, and White Oak Lake during the construction phase are expected to be negligible because soil erosion and dust control measures would be implemented as described in Section 4.5.1.3. In the absence of such controls, soil loss at a rate of approximately 405 metric tonnes/ha/year (181 tons/acre/year) (Appendix F.1) could be expected, and the impacts would be similar to those described in Section 4.5.1.3.

The impacts to Melton Branch, White Oak Creek, and White Oak Lake associated with facility operations are also expected to be negligible. The proposed facility would not release process and sanitary wastewater, and no sanitary water or process wastewater would be discharged directly to the environment. The total amount of sanitary wastewater generated over the life of the cementation facility would be 5,020 m^3 (1.33 million gal). The impacts of treating the additional wastewater at area wastewater treatment plants should be negligible for the same reasons discussed for the Low-Temperature Drying Alternative. Storm water would be managed similar to the methods Low-Temperature Drying Alternative.

The removal of the wastes from the SWSA 5 North trenches would have a positive impact on the surface waters of the Melton Valley and White Oak Creek Watersheds by reducing the amount of radionuclides that could be released to the surface waters of the area.

The impacts to surface water from D&D activities are expected to be negligible and generally similar to those discussed for construction and operations phase activities. No discharges of wastewater would take place during the D&D phase, and overall impacts to surface water during the D&D activities should be negligible.

4.5.1.6 Treatment and Waste Storage at ORNL Alternative

Impacts to White Oak Creek, Melton Branch, and White Oak Lake from the construction of waste treatment and storage facilities required for this alternative are expected to be negligible because soil erosion and dust control measures would be implemented during the construction of these facilities. In the absence of effective soil erosion controls, soil loss would be at a rate of 405 metric tonnes/ha/year (181 tons/acre/year) for this alternative (Appendix F.1), which would result in similar impacts to those described in Section 4.5.1.3.

The impacts to Melton Branch, White Oak Creek, and White Oak Lake during the facility operations of the waste treatment and storage facilities are also expected to be negligible. No sanitary wastewater or process wastewater would be discharged directly to the environment, with the exception of the vitrification treatment process wastewater, as discussed in Section 4.5.1.4. The impact of treating the additional waste at area wastewater treatment plants should be negligible for the reasons stated for the Low-Temperature Drying Alternative. Storm water would be managed as discussed for each of the previous treatment alternatives.

During institutional control, the interim storage of the TRU, remote-handled low-level, low-level, and mixed waste residuals in the new and existing waste storage facilities at ORNL should have no adverse impacts to the surface water because the wastes would be contained. The treatment of wastes removed from the SWSA 5 North trenches would have a beneficial impact on the surface waters of the Melton Valley and White Oak Creek Watersheds by reducing the amount of radionuclides released to surface water. However, after the loss of institutional control, waste constituents would eventually be released into the surface water. Impacts would be bounded by the No Action Alternative (Section 4.5.1.2), because the waste would be treated and better contained.

The impacts to surface water from D&D activities are expected to be negligible and generally similar to those discussed for construction and operations phase activities. No discharges of wastewater would take place during the D&D phase. Thus, overall impacts to surface water during D&D activities should be negligible.

4.5.1.7 Summary of Surface Water Impacts

The surface waters of the Melton Valley watershed would continue to be negatively impacted with the implementation of the No Action Alternative. Currently, the trenches in SWSA 5 North account for 6% of the strontium-90 and 3.6% of the cesium-137 in the surface waters measured at White Oak Dam for the Melton Valley Watershed (ORNL et al. 1997). The No Action Alternative would not involve any waste treatment, and the continued release of contaminants in the SWSA 5 North trenches would be a continuing source of contamination to the surface waters of the Melton Valley and White Oak Creek Watersheds. By comparison the treatment alternatives would treat the primary source of contamination that impact the surface waters of the Melton Valley Watershed. Facility operation impacts to surface water quality would be negligible for any of the treatment alternatives. Wastewater would not be treated onsite under the Low-Temperature Drying and Cementation Alternatives. The process wastewater from the vitrification facility would be occasionally drawn off the system and sent to an evaporator, with the condensate sent to a wastewater treatment facility for discharge into an NPDES-approved outfall. The extra step of sending excess process wastewater to the evaporator slightly increases the risk of releasing contaminants to the environment. Some construction-related erosion and storm water runoff would occur, but it is expected to be a minor influence on White Oak Creek and White Oak Lake.

4.5.2 Groundwater Impacts

This section discusses the environmental impacts to the area's groundwater resources. None of the alternatives would use groundwater as a direct source of water; therefore, impacts to groundwater quantity from usage were not evaluated. Water usage is discussed in Section 4.9.

4.5.2.1 Methodology

Methods used to analyze the impacts to groundwater conditions are listed below.

- Identified pathways through which groundwater contamination could occur.
- Quantified the types and levels of existing groundwater contamination.

4.5.2.2 No Action Alternative

Under the No Action Alternative, waste storage in the unlined trenches at SWSA 5 North would continue. The trenches have infiltration and seasonal inundation of groundwater, and have a "bathtubbing" effect intermittently throughout the year. These trenches are a source of contamination to groundwater and would continue to impact the groundwater in the Melton Valley and White Oak Creek Watersheds. The volume of contaminated groundwater is estimated to be approximately 1.3E+05 ft^3. Well samples in the area indicate elevated levels of americium-241 and curium-244 ranging up to 5,940 pCi/L [*Remedial Investigation Report on the Melton Valley Watershed at Oak Ridge, Tennessee* (DOE 1997a)].

Under the No Action Alternative, the TRU waste contained in the Melton Valley Storage Tanks and the various storage buildings and bunkers poses little threat to groundwater. A breach in tank integrity is unlikely in the near future under normal operating conditions, due to the nature of the sludge and supernate waste currently contained within the Melton Valley Storage Tanks and the 0.5-inch-thick 304 SS construction of these tanks. The materials stored in the various buildings and bunkers are primarily solids, and although the individual containment vessels (drums, rolloff boxes, etc.) lack the overall integrity of the Melton Valley Storage Tanks, an impact to groundwater is not expected.

After loss of institutional control, wastes in the trenches, bunkers, and buildings at SWSA 5 North and wastes in the Melton Valley Storage Tanks could enter the soils and eventually the groundwater due to containment failure.

4.5.2.3 Low-Temperature Drying Alternative

No direct groundwater impacts are anticipated from the construction, operation, and D&D activities of a low-temperature drying waste treatment facility, as the only discharge would be storm water runoff. Facility containment systems would keep spills (if they occur) from leaving the facility or site and percolating into the ground. Most loading and unloading of waste materials would be performed in paved areas that are not exposed to the weather or storm water runoff.

Groundwater elevation data obtained from an ORNL monitoring well located almost directly in the center of the proposed treatment facility site indicate that the groundwater is well below the foundation level of the facility. Due to very impervious material (silty clay); however, a potential of perched groundwater exists during wet-weather seasons. Any perched groundwater buildup behind the retaining wall and the south wall of the building would be relieved and diverted to the modified drainage area implemented for this alternative.

In addition, the facility would treat wastes contained in the SWSA 5 North trenches, thereby reducing the primary source of contamination in the SWSA 5 North area. As a result, the operation of this facility would have a beneficial impact on the groundwater of the area.

4.5.2.4 Vitrification Alternative

No direct impacts to groundwater would be expected from the construction, operation, and D&D activities of the vitrification facility, as the only discharge would be storm water runoff. Containment systems incorporated into the facility design would keep spills (if they occur) from leaving the facility or site and percolating into the ground. Most loading and unloading of waste materials would be performed in paved areas that are not exposed to the weather or storm water runoff.

Groundwater elevation data obtained from an ORNL monitoring well located almost directly in the center of the proposed treatment facility site indicate that the groundwater is well below the foundation level of the facility. Due to very impervious material (silty clay); however, a potential of perched groundwater exists during wet-weather seasons. Any perched groundwater buildup would be relieved and diverted to the modified drainage area implemented for this alternative.

In addition, the vitrification facility would treat the wastes contained in the SWSA 5 North trenches and thereby reduce the primary source of contamination in the SWSA 5 North area. As a result, the operation of this facility would have a beneficial impact on the groundwater of the area.

4.5.2.5 Cementation Alternative

No direct impacts to groundwater would be expected as a result from the construction, operation, and D&D activities of a cementation facility, as the only discharge from the facility would be storm water runoff. Containment systems are incorporated into the facility design, which would keep spills (if they occur) from leaving the facility or site and percolating into the ground. Most loading and unloading of waste materials would be performed in paved areas that are not exposed to the weather or storm water runoff.

Groundwater elevation data obtained from an ORNL monitoring well located almost directly in the center of the proposed treatment facility site indicate that the groundwater is well below the foundation level of the facility. Due to very impervious material (silty clay); however, a potential of perched groundwater exists during wet-weather seasons. Any perched groundwater buildup would be relieved and diverted to the modified drainage area implemented for this alternative.

In addition, the cementation facility would treat the waste contained in the SWSA 5 North trenches, thus reducing the primary source of contamination in the SWSA 5 North area. As a result, the operation of this facility would have a beneficial impact on the groundwater of the area.

4.5.2.6 Treatment and Waste Storage at ORNL Alternative

No direct impacts to groundwater would be expected from the construction, operation, and D&D activities of a treatment facility, or the construction and operation of storage facilities under this alternative, as the only discharge would be storm water runoff. Containment systems incorporated into the design for each facility would keep spills, if they occur, from leaving the facility or site and percolating into the ground. Most loading and unloading of waste materials would be performed in paved areas that are not exposed to the weather or storm water runoff.

The existing TRU waste bunkers are partially underground and are constructed in a manner to facilitate potential containment vessel failure. New waste storage facilities required for interim storage of the treated waste at ORNL would be constructed in a similar manner, so there would be no impact to the groundwater under normal waste storage conditions. In addition, a waste treatment facility would treat the waste contained in the SWSA 5 North trenches and thereby eliminate the primary source of contamination in the SWSA 5 North area. The impacts are expected to be primarily beneficial in light of attempts to remove the waste, treat, and store onsite. However, after the loss of institutional control, waste constituents would eventually be released into the groundwater. While impacts are bounded by the No Action Alternative, they are expected to be less because the waste would be treated and better contained.

4.5.2.7 Summary of Groundwater Impacts

No groundwater would be pumped for any of the alternatives; therefore, there are no impacts to groundwater quantity expected as a result of any action alternative. The implementation of the No Action Alternative would result in the continued release of radioactive contaminants from the SWSA 5 North trenches, especially strontium-90, into the near-surface groundwater and eventually into the surface water of White Oak Creek. After loss of institutional control all wastes from the Melton Valley Storage Tanks and the bunkers and buildings at SWSA 5 North could also be released. By comparison, the four action alternatives would remove and treat these wastes, eliminating a primary source of groundwater contamination in the SWSA 5 North area, and resulting in a beneficial effect on the environment. Under the Treatment and Waste Storage at ORNL Alternative however, contaminants could be released after the loss of institutional control. The impacts would be less than the impacts after loss of institutional control under No Action because the waste would be treated and better contained.

4.5.3 Wetlands and Floodplains Impacts

This section discusses the environmental consequences and impacts to wetlands and floodplains that would result from the implementation of the alternatives for the proposed action.

4.5.3.1 Methodology

Methods used to analyze the impacts to wetlands and floodplains are listed below.

- Determined whether a floodplain or wetland assessment was needed by:
  - determining the 100-year or 500-year floodplain from Federal Emergency Management Agency (FEMA) maps for the Melton Valley watershed;
  - identifying and mapping wetlands during a field survey performed in 1999 (Appendix C.1); and
  - comparing the locations of wetlands and floodplains with the areas expected to be disturbed by the construction, operations, and D&D activities of the treatment facility.
- Prepared as needed, a floodplain or wetland assessment.
- Evaluated whether stormwater runoff would affect wetlands or floodplains.

4.5.3.2 No Action Alternative

The TRU and alpha low-level waste currently stored in the Melton Valley Storage Tanks and the RCRA-permitted storage facilities under the No Action Alternative would not impact the six wetlands

(Figure 4-1) located in the area, nor the Melton Branch and White Oak Creek floodplains. Because essentially no wastes would be released from these facilities, no impacts to the wetlands and floodplains in the area would result from continued normal operations of this facility.

Radionuclide migration from the TRU and alpha low-level wastes stored in the unlined trenches at SWSA 5 North would continue to impact the floodplain in the SWSA 5 North area. The soils around the trenches and White Oak Creek indicated gamma contamination at the surface equal to 50 µrem/hour (DOE 1997a), which would continue to exist in the White Oak Creek floodplain.

Waste releases from the Melton Valley Storage Tanks and trenches, bunkers, and buildings at SWSA 5 North after loss of institutional control would eventually contaminate wetlands in the area.

4.5.3.3 Low-Temperature Drying Alternative

There would be an impact to Wetland B associated with the implementation of the Low-Temperature Drying Alternative. Wetland B, located on the eastern edge of the project site, would be adversely affected by construction of the proposed facility. Wetland B (Figure 4-1) is a 0.012-ha (0.03-acre) intermittent stream/seep that would be eliminated by construction, since installation of a culvert in this area would effectively drain this wetland. A wetlands assessment for this wetland (Appendix C.6) was performed per 10 *CFR* 1022, and coordination is ongoing with the State of Tennessee regarding possible mitigation for Wetland B.

Impacts to Wetlands D, E, and F (Figure 4-1) should be negligible as long as soil erosion is successfully controlled during construction. However, if soil erosion is not controlled during the construction phase, Wetlands D, E, and F could be adversely impacted temporarily by excessive siltation, which would be detrimental to aquatic biota in the wetlands. Impacts to Wetlands A and C (Figure 4-1) should be negligible because their locations are outside the areas to be cleared for construction and, due to mitigation measures, they would not be affected by siltation.

Under this alternative, there would be no construction in the Melton Branch and White Oak Creek 100-year and 500-year floodplains, and a floodplains assessment per 10 *CFR* 1022 is not required. Secondary impacts related to construction (sediment runoff) to the floodplains of Melton Branch and White Oak Creek are expected to be small as long as soil erosion measures are successfully instituted, as described for surface water (Section 4.5.1.3). Some deposition of soil would occur, but the impacts are only likely to be adverse if the soil erosion is unchecked.

Impacts to wetlands and floodplains from the operation and D&D of the proposed treatment facility are expected to be negligible. These impacts would be similar to those discussed for the construction and operation phase activities for surface water in Section 4.5.1.3.

The TRU and alpha low-level wastes stored in the unlined trenches at SWSA 5 North would be removed for treatment in the proposed facility. The removal of this waste would eliminate the primary source of contamination to the White Oak Creek floodplain in the area; however, secondary contamination from the soil and groundwater would continue to impact the White Oak Creek floodplain in the SWSA 5 North area. The soils around the trenches and White Oak Creek indicated gamma contamination at the surface equal to 50 µrem/hour (DOE 1997a), which would continue to exist in the White Oak Creek floodplain. This soil contamination would have to be remediated as a separate CERCLA action.

4.5.3.4 Vitrification Alternative

There would be an impact to Wetland B associated with the implementation of the Vitrification Alternative. Under this alternative, Wetland B (Figure 4-1) would also be eliminated by facility construction, since the installation of a culvert in this area would drain the wetland. A wetlands assessment (Appendix C.6) was performed per 10 *CFR* 1022, and coordination is ongoing with the State of Tennessee regarding possible mitigation for Wetland B. Impacts to Wetlands D, E, and F (Figure 4-1) should be negligible as long as soil erosion is successfully controlled during construction. However, if soil erosion is not controlled during the construction phase, Wetlands D, E, and F could be adversely impacted temporarily by excessive siltation, which would be detrimental to aquatic biota in the wetlands. Impacts to Wetlands A and C (Figure 4-1) should be negligible because their locations are outside the areas to be cleared for construction and, due to mitigation measures, they would not be impacted by excess siltation.

Under this alternative, there would be no construction in the Melton Branch and White Oak Creek floodplains, and a floodplains assessment per 10 *CFR* 1022 is not required. The construction impacts to the floodplains of Melton Branch and White Oak Creek are expected to be small as long as soil erosion measures are successfully instituted, as described for surface water (Section 4.5.1.3). Some deposition of soil would occur, but the impacts to the floodplain would only be adverse if the soil erosion is unchecked.

Impacts to wetlands and floodplains from the operation and D&D activities of the treatment facility are expected to be negligible. These impacts would be similar to those discussed for the construction and operation phase activities for surface water in Section 4.5.1.3.

The TRU and alpha low-level wastes stored in the unlined trenches at SWSA 5 North would be removed for treatment in the proposed facility. The removal of this waste would eliminate the primary source of contamination to the White Oak Creek floodplain in the area; however, secondary contamination from the soil and groundwater would continue to impact the White Oak Creek floodplain in the SWSA 5 North area. The soils around the trenches and White Oak Creek indicated gamma contamination at the surface equal to 50 μrem/hour (DOE 1997a), which would continue to have an impact on the White Oak Creek floodplain. This soil contamination would have to be remediated as a separate CERCLA action.

4.5.3.5 Cementation Alternative

There would be an impact to Wetland B associated with the implementation of the Cementation Alternative, since Wetland B (Figure 4-1) would be eliminated by facility construction. Installation of a culvert in this area would effectively drain this wetland. A wetlands assessment (Appendix C.6) was performed per 10 *CFR* 1022, and coordination is ongoing with the State of Tennessee regarding possible mitigation for Wetland B. Impacts to Wetlands D, E, and F (Figure 4-1) should be negligible as long as soil erosion is successfully controlled during construction. However, if soil erosion is not controlled during the construction phase, Wetlands D, E, and F could be adversely impacted temporarily by excessive siltation. Impacts to Wetlands A and C (Figure 4-1) should be negligible because their locations are outside the areas to be cleared for construction and, due to mitigation measures, they would not be impacted by excess siltation.

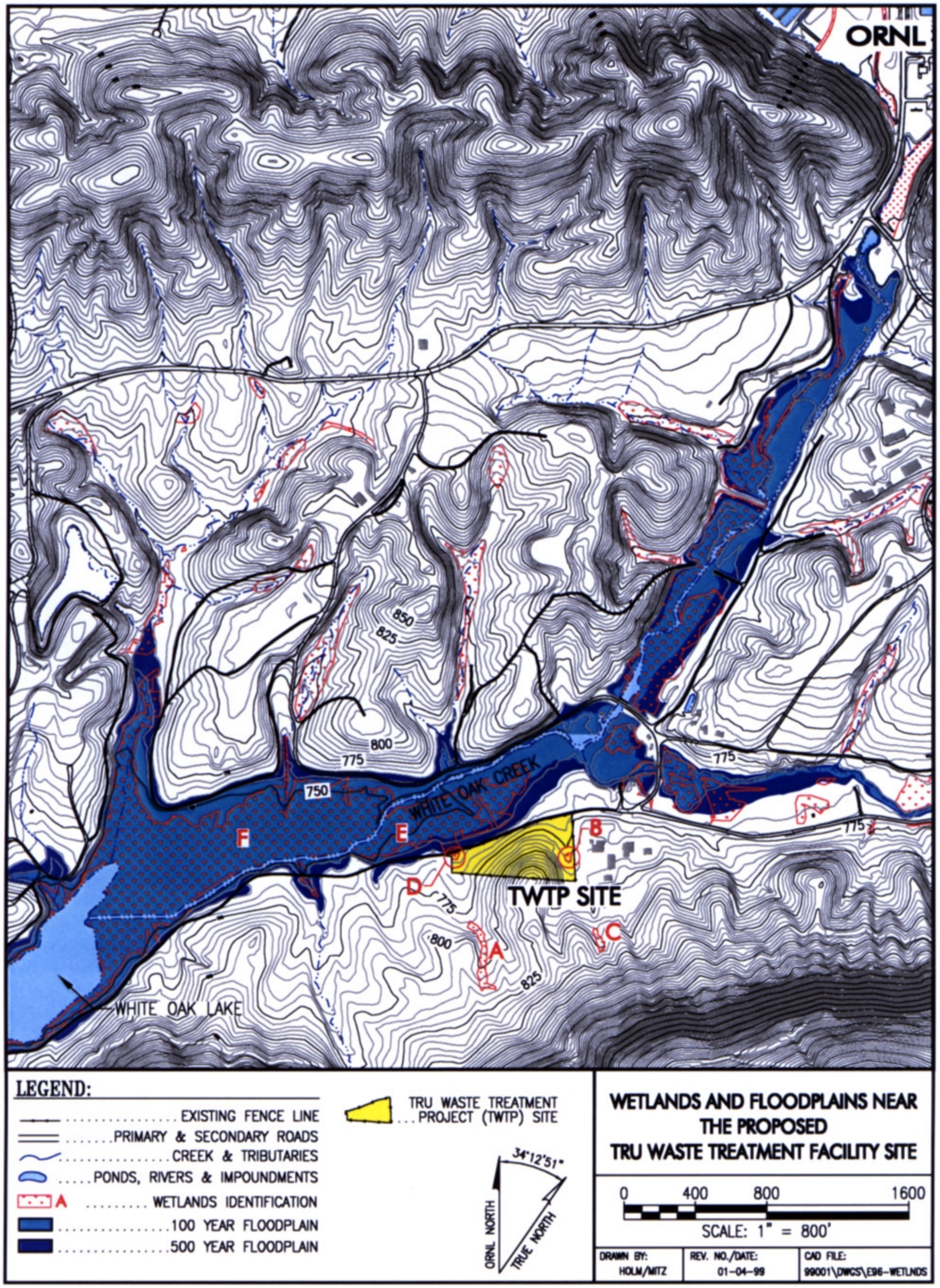

Figure 4-1. Wetlands near the proposed TRU Waste Treatment Facility site.

Under this alternative, there would be no construction in the Melton Branch and White Oak Creek 100- or 500-year floodplain; therefore, a floodplain assessment per 10 *CFR* 1022 is not required. The construction impacts to the floodplains of Melton Branch and White Oak Creek are expected to be small as long as soil erosion measures are successfully instituted, as described for surface water (Section 4.5.1.3). Some deposition of soil is likely to occur, but the impacts are only likely to be adverse if the soil erosion is unchecked.

Impacts to wetlands and floodplains from the operations and D&D activities of the treatment facility are expected to be negligible. These impacts would be similar to those discussed for the construction and operations and D&D phase activities for surface water in Section 4.5.1.3.

The TRU and alpha low-level wastes stored in the unlined trenches at SWSA 5 North would be removed for treatment in the proposed facility. The removal of this waste would eliminate the primary source of contamination to the White Oak Creek floodplain in the area; however, secondary contamination from the soil and groundwater would continue to impact the White Oak Creek floodplain in the SWSA 5 North area. The soils around the trenches and White Oak Creek indicated gamma contamination at the surface equal to 50 μrem/hour (DOE 1997a), which would continue to have an impact on the White Oak Creek floodplain. This soil contamination would have to be remediated as a separate CERCLA action under the FFA (See Section 8.2).

4.5.3.6 Treatment and Waste Storage at ORNL Alternative

Impacts to floodplains and wetlands during the institutional control period would be dependent on the treatment option selected. These impacts, which are discussed in Sections 4.5.3.3, 4.5.3.4, and 4.5.3.5, would include the elimination of Wetland B. The construction of additional waste storage facilities required for the interim storage of the treated wastes at ORNL should not impact any wetlands or floodplains. It is assumed that these facilities would be located in the same area as the existing solid waste storage facilities in Melton Valley. After the loss of institutional control, waste constituents would eventually be released into the ground and surface water affecting the floodplains and wetlands near SWSA 5 North. Impacts are bounded by the No Action Alternative, but releases should be less because waste would be treated and better contained.

4.5.3.7 Wetlands and Floodplains Impacts Summary

Under the treatment alternatives, Wetland B (Figure 4-1) would be eliminated due to construction. Installation of a culvert in this area would effectively drain the wetland if any of the treatment alternatives is implemented. A field survey to characterize this and other wetlands (Appendix C.1) was performed per 10 *CFR* 1022.11. In addition, a wetlands assessment for Wetland B (Appendix C.6) was conducted, and coordination is ongoing with the State of Tennessee regarding possible mitigation measures for this wetland.

There would be no construction in a floodplain, and a floodplain assessment under 10 *CFR* 1022 would not be required. Floodplain impacts would be small. The No Action Alternative would continue to impact the White Oak Creek floodplain due to radionuclide migration from the SWSA 5 North trenches during the institutional control period. After the loss of institutional control, loss of containment for all the wastes in both the Melton Valley Storage Tanks and the trenches, buildings, and bunkers at the SWSA 5 North area is assumed. These releases would adversely impact floodplains and wetlands in the White Oak Creek area.

4.6 WASTE MANAGEMENT AT ORNL

This section discusses the environmental impacts of the alternatives for the waste management operations at ORNL. Under the treatment alternatives, wastes included in the proposed action are:

- 900 m^3 of remote-handled TRU sludge,
- 1,600 m^3 of low-level supernate associated with the TRU sludges,
- 550 m^3 of remote-handled TRU waste/alpha low-level waste, and
- 1,000 m^3 of contact-handled TRU waste/alpha low-level waste.

The sludge and supernate contained in the Melton Valley Storage Tanks, which are highly mobile in the environment if spilled, would be changed to a much more environmentally benign waste form. Solid remote-handled and contact-handled solid wastes, and the wastes contained in the unlined trenches in SWSA 5 North, would be repackaged and compacted for off-site disposal.

Table 4-1 provides a comparison and summary of the estimated volumes of treated waste generated for each waste type for each alternative. Waste volumes were calculated by summing the wastes generated for the various waste categories for each treatment alternative shown in Tables 4-2, 4-3, and 4-4.

Table 4-1. Comparison of waste volumes generated by the alternatives that include waste treatment

Waste type	Low-Temperature Drying Alternative waste volumes (m^3)	Vitrification Alternative waste volumes (m^3)	Cementation Alternative waste volumes (m^3)
TRU	607	1,060	1,793
Remote-handled low-level waste	0	0	2,540
Low-level waste - primary	788	87	0
Low-level waste - secondary/D&D	1,990	4,893	2,833
Low-level waste/mixed - secondary	23	4	3
Sanitary wastes	1,760	7,201	7,437
Construction wastes	5,550	20,760	14,143
Recycle/reuse	115	120	77
TOTAL	10,833	34,128	28,826

m^3 = cubic meters.
D&D = decontamination and decommissioning.
TRU = transuranic.

The impacts of disposal of these wastes were evaluated separately [*Final Waste Management Programmatic Environmental Impact Statement for Managing Treatment, Storage, and Disposal of Radioactive and Hazardous Waste*, DOE/EIS-0200-F, May 1997 (DOE 1997e), and *Waste Isolation Pilot Plant Disposal Phase Final Supplemental Environmental Impact Statement*, DOE/EIS-0026-S-2, September 1997d)].

Table 4-2. Summary of projected waste volumes for the Low-Temperature Drying Alternative (the total of each waste category is summarized in Table 4-1)

Waste stream	Category	Projected volume out[a]	Treatment requirement
Primary Waste Streams			
Sludge (RH)	TRU	180 m^3	Dry, stabilize
Supernate/sludge wash water	Low-level waste	588 m^3	Dry, stabilize
CH solids	TRU	324 m^3	Various
RH solids	TRU	99 m^3	Various
Solids	Low-level waste	200 m^3	Various
Secondary Waste Streams			
Primary waste containers			
RH casks	Low-level waste	1,217 m^3	None
CH drums and boxes	Low-level waste	44 m^3	Compaction
Construction debris	Sanitary	~200 m^3	None
PPE (gloves, booties, etc.)	Low-level waste	214 m^3	Compaction
HEPA filters	Low-level waste	88 m^3	Compaction
Consumables (rags, towels, etc.)	Low-level waste	272 m^3	Compaction
Mechanical parts	Low-level waste/TRU	4 m^3	None
Aqueous waste filter media	Low-level waste	<20 m^3	Compaction
Steam from wet processing	N/A	N/A	Condense/HEPA filter
Changing/maintenance fluids	Low-level waste/mixed waste	<1 m^3	Stabilize, if required
Laboratory solvents and residues	Low-level waste/mixed waste/TRU	1 m^3	Thermal, none
Laboratory acid digistatis	Mixed waste	<20 m^3	Neutralize/stabilize
Sanitary wastewater	Sanitary	1,560 m^3	Capture
Decontamination and Decommissioning Waste Streams			
Category C, Concrete rubble	Construction debris	5,510 m^3	None
Category A, Free release materials	Recycle, reuse	115 m^3	None
Category B, Non-contaminated materials	Construction debris	30 m^3	None
Category B, Contaminated materials	Low-level waste	135 m^3	Compaction
Category D, Miscellaneous	Construction debris	<10 m^3	None
Category E, Special materials	Low-level waste/mixed waste	<1 m^3	Stabilize

[a]Volumes are waste product volumes in final disposal containers based on total inventory of waste (base + optional volumes) expected to be processed at the facility.

CH - contact-handled.
HEPA - High-Efficiency Particulate Air.
PPE - personal protective equipment.
RH - remote-handled.
TRU - transuranic.
~ - approximately.

Table 4-3. Summary of projected waste volumes for the Vitrification Alternative (the total of each waste category is summarized in Table 4-1)

Waste stream	Category	Projected Volume Out[a]	Treatment Requirement
Primary Waste Streams			
Sludge/Supernate	TRU	577 m^3	Vitrification
CH solids	TRU	260 m^3	Various
RH solids	TRU	116 m^3	Various
RH solids	Low-level waste	87 m^3	Various
Secondary Waste Streams			
Primary waste containers			
RH casks	Low-level waste	946 m^3	Volume reduction
CH drums and boxes	Low-level waste	44 m^3	Volume reduction
Construction debris	Sanitary	200 m^3	None
PPE (gloves, booties, etc.)[b]	Low-level waste	315 m^3	Volume reduction
HEPA filters[b]	Low-level waste	82 m^3	Volume reduction
Consumables (rags, towels, etc.)[b]	Low-level waste	181 m^3	Volume reduction
Mechanical/maintenance items	Low-level waste/TRU	97 m^3	Volume reduction
Industrial waste water	Low-level waste/ sanitary	1,108 m^3	Capture
Evaporator concentrate	Low-level waste	326 m^3	Cementation
Laboratory solvents and residues	Low-level waste/mixed waste/TRU	2 m^3	Vitrification, stabilization
Sanitary solids	Sanitary	718 m^3	Capture
Sanitary wastewater	Sanitary	6,283 m^3	Capture
Decontamination and Decommissioning Waste Streams			
Concrete rubble	Construction debris	20,712 m^3	None
Free release materials	Recycle, reuse	120 m^3	None
Non-contaminated materials	Construction debris	48 m^3	None
Contaminated materials	Low-level waste	1,894 m^3	Volume reduction
Vitrified and residual material	TRU	10 m^3	None
Special materials	Low-level waste/mixed waste	2 m^3	Stabilize, special treatment

[a]Volumes are waste product volumes in the final disposal containers.
[b]If the waste is determined to be hazardous, the waste would also be macroencapsulated.

CH - contact-handled.
HEPA - High-Efficiency Particulate Air.
PPE - personal protective equipment.
RH - remote-handled.
TRU - transuranic.

Table 4-4. Summary of projected waste volumes for the Cementation Alternative (the total of each waste category is summarized in Table 4-1)

Waste stream	Category	Projected Volume Out[a]	Treatment Requirement
Primary Waste Streams			
Sludge	TRU	1,287 m^3	Cementation
Supernate	RH low-level waste	2,453 m^3	Cementation
CH solids	TRU	260 m^3	Various
RH solids	TRU	116 m^3	Various
RH solids	RH low-level waste	87 m^3	Various
Secondary Waste Streams			
Primary waste containers			
RH casks	Low-level waste	946 m^3	Volume reduction
CH drums and boxes	Low-level waste	36 m^3	Volume reduction
Construction debris	Sanitary	200 m^3	None
PPE (gloves, booties, etc.)[b]	Low-level waste	384 m^3	Volume reduction
HEPA filters [b]	Low-level waste	83 m^3	Volume reduction
Consumables (rags, towels, etc.) [b]	Low-level waste	257 m^3	Volume reduction
Mechanical/maintenance items	Low-level waste/TRU	130 m^3	Volume reduction
Laboratory solvents and residues	Low-level waste/ mixed waste/TRU	2 m^3	Vitrification, stabilization
Sanitary solids	Sanitary	2,217 m^3	Capture
Sanitary wastewater	Sanitary	5,020 m^3	Capture
Decontamination and Decommissioning Waste Streams			
Concrete rubble	Construction debris	14,111 m^3	None
Free release materials	Recycle, reuse	77 m^3	None
Non-contaminated materials	Construction debris	32 m^3	None
Contaminated materials	Low-level waste	1,127 m^3	Volume reduction
Special materials	Low-level waste/ mixed waste	1 m^3	Stabilize, special treatment

[a]Volumes are waste product volumes in the final disposal containers.
[b]If the waste is determined to be hazardous, the waste would also be macroencapsulated.

CH - contact-handled.
HEPA - High-Efficiency Particulate Air.
PPE - personal protective equipment.
RH - remote-handled.
TRU - transuranic.

4.6.1 Methodology

Methods used to analyze the impacts of each alternative are listed below.

- Determined the estimated waste volumes and waste classifications for each alternative (Appendix B)].

- Determined available solid waste storage capacity and calculated additional waste storage needs, as appropriate.

4.6.2 No Action Alternative

The No Action Alternative assumes institutional control of the wastes defined in the proposed action for 100 years, during which surveillance, maintenance, and tracking activities would be required for the wastes. Under the No Action Alternative, legacy sludge and supernate would continue to be stored in the Melton Valley Storage Tanks. Remote-handled and contact-handled TRU solid wastes would continue to be stored in the existing solid waste storage facilities for TRU waste.

- Buildings 7855 and 7883 are bunkers, which would continue to store remote-handled TRU waste. Building 7855 is at capacity, with 157.2 m^3 (5552 ft^3) of remote-handled TRU waste in storage. Building 7883 currently stores 10.7 m^3 (377 ft^3) of remote-handled TRU solids and has an available storage capacity of 146.7 m^3 (5179 ft^3) ;

- Buildings 7572, 7574, 7842, 7878, and 7879 are metal buildings that would continue to store contact-handled TRU waste. These storage buildings currently store over 906 m^3 (32,000 ft^3) of contact-handled TRU wastes. Building 7842 is at capacity, but the other buildings have a combined available storage capacity of 722 m^3 about (25,500 ft^3) for contact-handled TRU wastes.

- The below-grade concrete cells in SWSA 5 North (Buildings 7826 and 7834) currently store about 68 m^3 (2,400 ft^3) of remote-handled TRU and contact-handled TRU wastes, but are not RCRA permitted. This waste is scheduled to be moved to the appropriate existing storage facilities described above as a legacy waste action under CERCLA in Fiscal Year 2000, reducing the amount of available storage space in these facilities.

- Solid TRU waste would continue to be buried in 23 trenches and 8 auger holes used for the retrievable storage of TRU waste in SWSA 5 North.

Removal, treatment, and disposal of the retrievable TRU waste from portions of SWSA 5 North is considered a major component of the selected remedy for the Melton Valley Watershed at ORNL according to the Draft Record of Decision for the Melton Valley Watershed (*Record of Decision for the Melton Valley Watershed at Oak Ridge National Laboratory, Oak Ridge, Tennessee*, DOE/OR/01-1826&D1). In addition, an Interim Record of Decision (issued in connection with the FFA among EPA, TDEC, and DOE under CERCLA) and an Action Memorandum require the TRU waste from the Gunite and Associated Tanks Remediation Project (DOE 1997b) and from the Old Hydrofracture Facility Tanks Remediation Project (DOE 1997c), respectively, to be treated and disposed of along with the TRU waste from the Melton Valley Storage Tanks. This tank waste is included in the total waste volume slated for treatment in the TRU Waste Treatment Facility. If the No Action Alternative were implemented, these two Interim Records of Decision for the ORNL tanks, the Draft Record of Decision for the Melton Valley Watershed, and potentially the upcoming Draft Record of Decision for the Bethel Valley Watershed at ORNL could be affected, and would require amendments and renegotiations with stakeholders and the appropriate regulatory agencies.

There are also legal mandates that require DOE to address legacy TRU waste management needs. DOE has been directed by the TDEC and the EPA to address environmental issues including disposal of its legacy TRU waste. DOE is under a TDEC Commissioner's Order (September 1995) to implement the Site Treatment Plan (under the Federal Facility Compliance Act) that mandates specific requirements for the treatment and disposal of ORNL's TRU waste. The primary milestone in the Commissioner's Order is that DOE begin treating legacy TRU sludge in order to make the first shipment to the Waste Isolation Pilot Plant in New Mexico by January 2003. The No Action Alternative would result in noncompliance with the ORNL Site Treatment Plan and the TDEC Commissioner's Order, which requires TRU waste treatment and off-site storage. Under RCRA, Section 3008(a), DOE could be fined up to $25,000 per day per noncompliance, in addition to any fines that could accumulate from the State if this legacy TRU waste is not treated and disposed offsite.

4.6.3 Low-Temperature Drying Alternative

The implementation of the Low-Temperature Drying Alternative would have a positive impact on waste management operations at ORNL. Since the treated wastes would be disposed offsite, the beneficial impact of this alternative on ORNL is a substantial reduction in the amount of waste stored onsite. Impacts from continued storage of the wastes at ORNL would be significantly reduced once the project treats, packages, and transports the waste offsite for disposal. Under this alternative, certain nonradioactive construction, office, sanitary, industrial, and demolition wastes would be disposed of at appropriate local facilities. An estimated total of 10,833 m^3 of waste would be generated under this alternative (Table 4-1). This is the lowest total combined volume for the treatment alternatives analyzed. Table 4-2 details the volumes by waste type.

4.6.3.1 Primary waste

The Low-Temperature Drying Alternative would treat and package the primary waste streams identified in the proposed action and summarized in Section 4.6 for final disposition. Table 4-2 provides details on the types and quantities of wastes generated from the Low-Temperature Drying Alternative. For comparative purposes, these data were summarized and compared to similar data for the other action alternatives in Table 4-1.

4.6.3.2 Secondary and other wastes

In addition to the treated primary waste streams, there would be several other waste streams generated by the Low-Temperature Drying Alternative, including: secondary wastes generated from the treatment and management of the primary waste streams [includes HEPA filters, sanitary wastewater and solids, personal protective equipment (PPE), etc.]; and D&D waste (includes contaminated materials, free release materials, concrete rubble, etc.).

The Low-Temperature Drying Alternative includes measures to minimize the quantity of secondary and D&D wastes that would be generated. Waste minimization was incorporated into the planning, design, and operations of the low-temperature drying waste treatment facility. Materials, equipment, and systems were selected based on consideration for potential waste generation. For example, steel used for certain construction materials or shielding was chosen over concrete due to the recycling opportunity and the reduction in volume of waste generated during D&D activities. Based on equipment design and facility operating requirements, other waste minimization techniques and objectives include:

- minimize contaminated work areas and spaces,
- reduce equipment maintenance requirements due to short service lives,
- avoid operations that lead to the spread of contamination,
- simplify segregated material handling and flow paths,
- limit work-in-progress waste inventories at the facility,
- minimize waste handling iterations at the facility, and
- use mechanical interfaces for contamination control.

During operations, secondary wastes such as consumables (e.g., PPE, step-off pads, rags, etc.) are generated and disposed of in packages being prepared for disposal at a low-level waste disposal facility. The solid waste containers used in delivering primary waste to the facility would also be considered secondary waste (e.g., drums, boxes, and concrete casks) and would be sized, volume reduced, and packaged for disposal. Volume-reduction (compaction, sorting, surveying, and segregation) techniques would be used to reduce the waste product volume prior to shipping and disposal.

Two nonradiological secondary waste streams generated during construction operations would be construction debris and sanitary waste. Sanitary waste would be generated at the highest rates during the construction phase of the project due to the number of personnel onsite. Sanitary wastewater would be routinely trucked offsite to a wastewater treatment plant. Only a minimal quantity of waste, generated through required maintenance and laboratory activities, has a potential for becoming a mixed low-level waste, thus requiring disposal at an appropriate mixed waste disposal facility.

D&D wastes would be generated following closure of the low-temperature drying waste treatment facility. Much of the equipment used for waste treatment would be classified as low-level waste and would require disposal at the Nevada Test Site. The surfaces of the treatment facility and most equipment would be kept relatively clean throughout the life of the facility. Therefore, although contamination would include TRU activity, the concentrations of the TRU radionuclides would be considerably less than the upper limit for low-level waste. Whenever safely and economically feasible, equipment and building components originating from the D&D activities of the low-temperature drying facility would be released for reuse or recycle for another waste remediation project. Uncontaminated building concrete would be sent to a construction debris landfill for permanent disposal.

Treatment of the legacy TRU waste and disposal offsite would result in compliance with the legal mandates regarding management of this waste. Once treatment is complete, existing solid waste storage facilities may be closed reducing the “mortgage” expenses required for maintaining these facilities. Upon completion of the project, the Melton Valley Storage Tanks would be returned to DOE control.

4.6.4 Vitrification Alternative

The implementation of the Vitrification Alternative would have a positive impact on waste management operations at ORNL. Since the treated wastes would be disposed offsite, the beneficial impact of the Vitrification Alternative on ORNL is a substantial reduction in the amount of primary legacy waste stored at the site. Impacts from continued storage of the wastes at ORNL would be reduced once the project treats, packages, and transports the waste offsite for disposal. Under this alternative, certain nonradioactive construction, office, sanitary, industrial, and demolition waste would be disposed of at appropriate local facilities. An estimated total of 34,128 m^3 of waste would be generated under this alternative. This is the largest total combined waste volume for the treatment alternatives although much of the waste volume is due to construction, sanitary, and D&D wastes. Table 4-3 details the types and quantities of wastes generated from the Vitrification Alternative.

4.6.4.1 Primary waste

The Vitrification Alternative would treat and package the primary waste streams identified in the proposed action for final disposition (see Section 4.6). The sludge and supernate contained in the Melton Valley Storage Tanks, which are highly mobile in the environment if spilled, would be treated by vitrification and changed into a stabilized, environmentally benign, waste glass form. Solid remote-handled and contact-handled solid wastes, and the wastes contained in the unlined trenches in SWSA 5 North, would be compacted and repackaged for off-site disposal.

4.6.4.2 Secondary and other waste

Sanitary waste would be generated at similar rates during the construction and operating phases of the Vitrification Alternative. As shown in Table 4-1, sanitary waste generation is five times greater than the amount produced by the Low-Temperature Drying Alternative. Only a minimal quantity (4 m^3) of low-level/mixed waste is expected to be produced by this alternative.

This alternative would generate approximately 20,760 m^3 of construction wastes, the largest volume of construction debris under any of the treatment alternatives. In general, there would be a substantially greater quantity of low-level secondary and D&D wastes generated from the Vitrification Alternative (4,893 m^3) because of the larger process building and the additional equipment required for the vitrification process. It is expected that much of the melter would have to be cut up and disposed of as TRU waste.

Treatment of the legacy TRU waste and offsite disposal of the treated waste would result in compliance with the legal mandates regarding management of this waste. Once treatment is complete, existing solid waste storage facilities may be closed, reducing the "mortgage" expenses for maintaining these facilities. Upon completion of the project, the Melton Valley Storage Tanks would be returned to DOE control.

4.6.5 Cementation Alternative

The implementation of the Cementation Alternative would have a positive impact on waste management operations at ORNL. Because the treated, wastes would be disposed offsite, the beneficial impact of this alternative on ORNL is a substantial reduction in the amount of primary legacy waste stored at the site. Impacts from continued storage of the wastes at ORNL would be reduced once the project treats, packages, and transports the waste for off-site disposal. Under this alternative, certain nonradioactive construction, office, sanitary, industrial, and demolition wastes would be disposed of at appropriate local facilities. An estimated total of 28,826 m^3 of waste would be generated under this alternative (Table 4-1). Table 4-4 details the types and quantities of wastes generated from the Cementation Alternative.

4.6.5.1 Primary waste

The Cementation Alternative would treat and package the primary waste streams (Section 4.6.) for final disposition. The sludge and supernate contained in the Melton Valley Storage Tanks, which are highly mobile in the environment if spilled, would be treated by cementation, which involves the mixing of the waste material with additives to form a stabilized, environmentally benign, cement-like waste product. Treatment by cementation would result in an increased volume of the primary waste stream (from 4,050 m^3 before treatment to 4,203 m^3 after treatment). By comparison, primary waste volumes are reduced by low-temperature drying from 4,050 m^3 to 1,391 m^3 and from 4,050 m^3 to 1,040 m^3 by vitrification. The treatment timeframe is longer for the Cementation Alternative in order to meet the requirements of the shipment capacity allotment given by Waste Isolation Pilot Plan to each approved shipper. Solid remote-handled and contact-handled solid wastes, and the wastes contained in the unlined trenches in SWSA 5 North, would be repackaged and compacted for off-site disposal.

4.6.5.2 Secondary and other waste

The Cementation Alternative requires more equipment than the Low-Temperature Drying Alternative and, therefore, would generate substantially more maintenance waste (130 m^3). In addition, the Cementation Alternative would produce 2,540 m^3 of remote-handled low-level waste compared to none for the other two treatment alternatives (Table 4-1). The D&D approach would be similar to the Vitrification Alternative (e.g., replace and remove the cementation process equipment). However, it is not expected that the processing equipment would be classified as TRU, so disposal at the Waste Isolation Pilot Plant should not be required.

Treatment of the legacy TRU waste followed by offsite disposal would result in compliance with the legal mandates regarding management of this waste. Once treatment is complete, existing solid waste storage facilities may be closed reducing the “mortgage” expenses for maintaining these facilities. Upon completion of the project, the Melton Valley Storage Tanks would be returned to DOE control.

4.6.6 Treatment and Waste Storage at ORNL Alternative

This alternative would consist of the treatment of the primary wastes followed by interim storage at ORNL. Due to volume reduction and other process differences, the lowest total waste volume (10,833 m^3) is associated with treatment by low-temperature drying. Treatment by vitrification would generate a total of 34,128 m^3 of wastes, and treatment by cementation would produce a total of 28,826 m^3 of wastes.

The construction of the additional storage facilities needed to handle the excess treated, secondary, and D&D wastes would have to coincide with the construction of the treatment facility in order to be ready for the receipt of the treated waste streams. If this alternative were chosen, it is assumed that the existing bunkers could be used to store treated remote-handled TRU wastes, and the new waste storage facilities would be located in the Melton Valley area of ORNL, preferably near the waste treatment facility. In addition, it is assumed that the storage facility footprint would be similar to the existing storage facilities and have a similar waste storage capacity (approximately 150 m^3 for remote-handled TRU waste, and 300 m^3 for other waste types). Existing storage facilities for storage of contact-handled TRU waste, which have a combined capacity of 1,631 m^3 (57,632 ft^3), could be used for storage of treated low-level waste. The building footprint used for these calculations also includes any shielding requirements. Table 4-5 provides a summary of the volumes of treated waste generated by each treatment alternative, and the space required for construction of additional waste storage facilities.

Following construction of the additional waste storage facilities, there would also be surveillance, maintenance, and tracking required to properly manage this waste and the associated facilities if this alternative were implemented.

There are also legal mandates that require DOE to address legacy TRU waste management needs. DOE has been directed by the TDEC and the EPA to address environmental issues including disposal of its legacy TRU waste. DOE is under a TDEC Commissioner's Order (September 1995) to implement the Site Treatment Plan (under the Federal Facility Compliance Act) that mandates specific requirements for the treatment and disposal of ORNL's TRU waste. The primary milestone in the Commissioner's Order is that DOE begin treating legacy TRU sludge in order to make the first shipment to the Waste Isolation Pilot Plant in New Mexico by January 2003. The Treatment and Waste Storage at ORNL Alternative would result in noncompliance with the ORNL Site Treatment Plan and the TDEC Commissioner's Order, which requires TRU waste treatment and off-site storage. Under RCRA, Section 3008(a), DOE could be fined up to $25,000 per day per noncompliance, in addition to any fines that could accumulate from the State if this legacy TRU waste is not treated and disposed offsite.

4.6.7 Waste Management Impacts Summary

The waste volumes discussed in the proposed action and summarized in Section 4.6 would remain in their current state with the implementation of the No Action Alternative. This alternative would result in continued surveillance, maintenance, and tracking activities for the waste. This alternative and the Treatment and Waste Storage at ORNL Alternative would also be in violation of the ORNL Site Treatment Plan and the TDEC Commissioner's Order (September 1995) requiring the treatment and off-site disposal of legacy TRU waste, which could result in large monetary fines for DOE, as compared to the alternatives that include waste treatment and off-site disposal (low-temperature drying, vitrification, and cementation), which would help DOE meet its regulatory requirements.

Table 4-5. Summary of the TRU, mixed low-level, remote-handled low-level, and low-level waste volumes (including D&D wastes), the resulting new storage space required for each treatment alternative, and the land area required for additional storage facilities

	Low-Temperature Drying	Vitrification	Cementation
Table 4-5a. Summary of the TRU, mixed low-level, and remote-handled low-level waste volumes and new storage space required			
Treated TRU waste volume (m^3)[d]	607	1,060	1,793
Mixed low-level waste volume (m^3)	23	4	3
Treated remote-handled low-level waste volume (m^3)	–	–	2,540[a]
Total TRU, mixed, and remote-handled low-level waste requiring on-site storage (m^3)	630	1,064	4,336
Existing waste bunkers storage capacity (m^3)	320	320	320
New storage capacity needed (m^3)[b]	310	744	4,016
Assumed capacity of single new waste bunker (m^3)	150	150	150
Number of new waste bunkers needed	3	5	27
Assumed area of new waste bunker (m^2)	234	234	234
Total Storage Facility Area required for TRU, mixed, and remote-handled low-level wastes (m^2)	702	1,161	6,265
Table 4-5b. Summary of low-level waste volumes and new storage space required			
Total low-level waste requiring on-site storage (m^3)	2,778 [a]	4,983 [a]	2,833 [a]
Existing storage capacity (metal building)	1,631	1,631	1,631
New storage capacity needed (m^3) [b]	1,147	3,352	1,202
Assumed capacity of single new metal building (m^3)	300	300	300
Number of new metal buildings needed	4	11	4
Area of new metal buildings (m^2)	375	375	375
Total area required for low-level wastes (m^2)	1,434	4,190	1,503
Table 4-5c. Total area required for all waste types and the associated land requirements for the new storage facilities			
TOTAL FACILITY SPACE REQUIRED FOR ALL WASTE TYPES (m^2)	**2,136**	**5,351**	**7,768**
TOTAL HECTARES REQUIRED FOR NEW WASTE STORAGE FACILITIES[c]	**0.3**	**0.6**	**0.8**

[a]Total waste volumes include alpha-low-level waste.

[b]Determined by subtracting available capacity from resulting waste volume and dividing by assumed storage capacity of new facility (150 m^3 for TRU, mixed, and remote-handle low-level wastes, and 300 m^3 for low-level wastes).

[c]Determined by summing storage space required for all waste types, for each treatment method, and converting to hectares.

[d]TRU waste volumes include both remote-handled and contact-handled waste.

For the alternatives that include waste treatment, secondary wastes would be generated during the construction, treatment, and D&D activities. Because of the volume reduction associated with the treatment method, the Low-Temperature Drying Alternative would result in the lowest total volume (10,833 m^3) of treated, secondary, and D&D wastes of the treatment alternatives. The Vitrification Alternative would produce a total of 34,128 m^3, and the Cementation Alternative would generate a total of 28,826 m^3 of wastes. These wastes would be disposed off-site in an appropriate permitted disposal facility for the treatment alternatives that include disposal. If the Treatment and Waste Storage at

ORNL Alternative were implemented, additional waste storage facilities would be required (total space ranging from 0.3 to 0.8 ha or 0.75 to 2.0 acres) depending upon the treatment process selected.

4.7 AIR QUALITY

This section discusses the impacts to air quality resulting from the construction, operation, and D&D of the proposed treatment facility. Because the alternatives would take place in an attainment area for all criteria air pollutants, no Clean Air Act conformity determination is required. There are no sensitive human populations such as children, the elderly, or hospital patients within five miles of the proposed facility. There are no known species of biota which are particularly sensitive to air emissions near the facility. Human health impacts from air emissions are addressed in Section 4.10. Impacts associated with accidental releases of air pollutants are addressed in Section 4.11.

4.7.1 Methodology

Methods used to determine the impacts from the alternatives are listed below.

- Qualitatively discussed vehicle and dust emissions.
- Calculated air emissions using mass balances for the treatment alternatives (Appendix B).
- Compared the projected air emissions to the National Ambient Air Quality Standards, and qualitatively to the Class I prevention-of-significant deterioration (PSD) areas.
- Calculated radiological emissions based on an assumed HEPA filter efficiency of 99% each for two filters used in sequence.
- Calculated metals emissions based on an assumed HEPA filter efficiency of 99% each for two filters used in sequence.
- Assumed organic constituents were completely emitted to provide a conservative estimate of total air emissions.
- Computed dose rates for the nearest off-site locations for the maximally exposed individual (MEI) using projected emission rates (Appendix B) and CAP88 model.

4.7.2 No Action Alternative

Under the No Action Alternative no air emissions are expected from the TRU waste storage at ORNL.

4.7.3 Low-Temperature Drying Alternative

Potential air contaminants would include vehicle emissions and fugitive dust from construction, which are both easily mitigated using proper equipment and control measures or techniques. During facility operations, air pollutants could potentially be emitted from the proposed facility (stationary source), and would be emitted by vehicles driven by workers, or used to transport waste to the facility and from the facility (mobile sources).

The Low-Temperature Drying Alternative is not expected to adversely impact air quality during facility operations. The emissions from the proposed treatment facility were estimated by considering all the constituents of the waste that would be processed in the facility. Calculations indicate that the air emissions from a low-temperature drying waste treatment facility during normal operations would be below the State of Tennessee limits for air permitting exemptions (Table 4-6). The estimated emissions would be 62% to 86% of the allowable exemption.

Table 4-6. Estimated air emissions from the proposed Low-Temperature Drying treatment facility and State of Tennessee permit exemptions

Compound	Emission	Exemption	Regulatory citation
Volatile organics	0.062 lb/h	0.1 lb/h	1200-3-9-.04(h)
Particulate matter	0.086 lb/h	0.1 lb/h	1200-3-9-.04(I)
Radionuclides	0.063 mrem/year	0.1 mrem/year	1200-3-9-.04(I)

The concentrations of hazardous air pollutants, except for uranium, projected for off-site locations are generally several orders of magnitude below recently measured concentrations (Table 4-7) at the same locations and, therefore, do not measurably contribute to the ambient air concentration. These treatment emissions were calculated based on the chemical and physical characteristics of the waste and the efficiency of removal by the HEPA filters. Uranium is projected to cause a small, but possibly detectable increase (less than 50%) in the measured ambient air concentrations of hazardous air pollutants.

Table 4-7. Average concentrations of hazardous air pollutants measured at ORR and projected maximum concentrations from the Low-Temperature Drying Alternative

Hazardous air pollutant	Measured ORR average concentration ($\mu g/m^3$)	Low-Temperature Drying Alternative projected maximum concentration ($\mu g/m^3$)
Arsenic	6×10^{-4}	1×10^{-8}
Cadmium	2.7×10^{-4}	5.2×10^{-9}
Chromium	8×10^{-4}	1.9×10^{-7}
Lead	3.4×10^{-3}	2.5×10^{-7}
Uranium	7×10^{-5}	2.7×10^{-5}

The conservative total estimated radiological emissions of 5.44-03 curies/year for the Low-Temperature Drying Alternative is based upon a HEPA filter efficiency of only 99% for each filter in a series of two, instead of the design efficiency of 99.97% for each filter for very small particles. Higher efficiencies are likely for larger particles. CAP 88 was used to calculate doses. This emission rate yields a maximum dose of 0.063 mrem/year at about 100 m (328 ft) southwest of the stack and about 0.023 mrem/year at 1,250 m (4,101ft) southwest of the stack (closest off-site location) and 0.019 mrem/year at 1,250 m (4,101 ft) northeast of the site. The off-site dose of 0.023 mrem/year should be compared to the MEI of the general public from airborne radionuclides from the ORR, or 0.41 mrem/year. The maximum estimated dose resulting from the Low-Temperature Drying Alternative based on the conservative emission rates, is generally within the uncertainty of the dose to the MEI of the general public from airborne radionuclides. The use of HEPA efficiencies closer to the design efficiency would further reduce the estimated dose from the facility.

Virtually all of the radionuclides in the TRU waste are nonvolatile and would only be released during D&D activities as part of demolition dust and debris. The potential concentrations of radionuclides in the demolition dust would depend upon the contamination resulting from operations, the effectiveness of facility decontamination, and the demolition processes used for the D&D of the proposed facility.

4.7.4 Vitrification Alternative

Potential air contaminants for the Vitrification Alternative, during construction, would include vehicle emissions and fugitive dust, which are both easily mitigated using proper equipment and control measures or mitigation techniques. These potential releases during normal facility operations and during D&D activities include radionuclide emissions, particulate matter emissions, and volatile organic emissions (associated only with tank waste treatment).

The primary means of mitigating treatment-related air emissions is an effective off-gas system. The Vitrification Alternative off-gas consists of a complex mixture of entrained particulates, gases, and vapors that result from the thermal processes occurring in the melter. The vitrification off-gas system would exhaust gases from the melter plenum, maintain the melter at a negative pressure in relation to the cell, and clean the off-gas-to-stack discharge. Off-gas treatment for this alternative would be accomplished with two systems. The primary off-gas system for the Vitrification Alternative consists of three components: a film cooler, an off-gas quencher, and a high-efficiency mist eliminator (HEME) with condensate tank and scrubber. The primary off-gas system would be designed to provide a total decontamination factor of at least 2.5E+12 and a decontamination factor for semivolatile/condensing products of at least 8E+08. The decontamination factors were provided by personnel in the DOE Savannah River Plant design group who are working on a vitrification design (Savannah River Plant 1999). The system, up to and including the HEMEs, would remove up to 99% of radionuclide activity.

The secondary off-gas treatment system would remove acid gases from off-gas and perform final filtration of particulates prior to stack discharge. The secondary off-gas system consists of a selective catalytic (NO_x) reduction (SCR) unit, HEPA filters, and a wet scrubber. The SCR uses a catalyst bed and ammonia to convert NO_x to nitrogen and water. The SCR is expected to remove about 90% of the NO_x. HEPA filters would remove about 99.97% of the remaining particulates in the off-gas stream. A wet scrubber would eliminate the release of any remaining acid gases and any unreacted ammonia. Collected material from the off-gas system would be recycled back through the vitrification facility for processing, eliminating it as a waste stream. Since emissions from the vitrification system with state-of-the-art off-gas treatment would be similar to the Low-Temperature Drying Alternative (except higher nitrogen oxide emissions would be expected), Low-Temperature Drying Alternative emissions are considered the bounding case.

The Vitrification Alternative is expected to comply with applicable air standards. Similar vitrification off-gas systems have been effectively employed for vitrification facilities at other DOE sites with emissions within exempted levels (Savannah River Plant 1999). Although highly unlikely, if emission exemption limits, as outlined in Table 4-6, could not be attained with the specific equipment, then air permits would be required.

4.7.5 Cementation Alternative

Potential air contaminants during construction of a cementation waste treatment facility would include vehicle emissions and fugitive dust, which are both easily mitigated. Most operational off-gas problems, and the associated environmental and health and safety risks, are eliminated with the cementation treatment method. These potential releases during normal operations, and to some extent during D&D activities, include radionuclide emissions, particulate matter emissions (primarily metals), and volatile organic emissions (associated only with process of tank wastes). The cementation mixing process has provisions for dust collection and filtration (i.e., a dust collection baghouse to prevent particulates and fine particles from entry into the building ventilation system). The dust collection baghouse would transfer the collected dust back into the cementation system by way of the mixer. With a properly designed dust and vapor collection system, the emissions from a cementation waste treatment facility, based on engineering judgment, are assumed to be similar to those for the Low-Temperature Drying Alternative (except higher particulate emissions would be expected). The Low-Temperature Drying Alternative emissions are considered the bounding case. Therefore, the air emissions from the cementation facility during normal operations are projected to be below the State of Tennessee limits for air permitting exemptions, as indicated in Table 4-6.

4.7.6 Treatment and Waste Storage at ORNL Alternative

As discussed for the other treatment alternatives, potential air contaminants during construction would include vehicle emissions and fugitive dust, which are both easily mitigated. These potential releases during normal operations, and D&D activities, includes radionuclide emissions, particulate matter emissions (primarily metals), and volatile organic emissions (associated only with process of tank wastes). Air emissions from normal operations; and permit requirements (regulatory exemptions) would be the same as those discussed in the previous sections for the treatment alternatives (Sections 4.7.3, 4.7.4, and 4.7.5). Air quality is not expected to be impacted during storage of the treated waste.

4.7.7 Air Quality Impacts Summary

Under No Action, there are no known air emissions from the TRU waste in storage at ORNL. Construction and D&D activities associated with the other alternatives would result in minor, short-term fugitive dust emissions. Air emissions during normal operations of the proposed treatment facility would be below State of Tennessee permit exemption concentrations. Air quality is not expected to be impacted from storage of treated waste.

4.8 TRANSPORTATION IMPACTS

This section discusses the impacts and consequences associated with on-site retrieval and transport of solid waste to and from the treatment facility and the off-site transportation of treated waste for the action alternatives. It also addresses the construction of on-site storage facilities for the Treatment and Waste Storage at ORNL Alternative. The off-site truck transportation analysis was done using routing models following the general principle of minimizing distance and transportation time. They are representative of routes which serve to bound transportation impacts. They do not necessarily present actual routes. Actual routes would be determined in accordance with Federal and State authorities and DOE policy. Route changes constrained by regulation should not create a significant deviation in the effects described.

4.8.1 Methodology

4.8.1.1 Solid waste on-site retrieval and transport from trenches, bunkers, and buildings

Approximately 200 casks of remote-handled TRU solid waste stored in 23 trenches at SWSA 5 North would be retrieved. Additionally, approximately 100 casks of remote-handled TRU and 1,000 m^3 (five thousand 55-gal drum-equivalents or 250 shipments) of contact-handled TRU waste would be retrieved from aboveground buildings and bunkers at SWSA 5 North and transported to the proposed TRU Waste Treatment Facility.

Retrieval of Subsurface Remote-handled TRU Containers

Retrieval of subsurface remote-handled TRU casks would involve removal of about 5 ft of soil overburden and hand-rigging the casks with lifting cable so they can be retrieved from the trenches.

A temporary enclosure (e.g., a Rubb tent) equipped with negative-pressure ventilation for containment and HEPA filtration system would be required so that all excavation and retrieval activities would be conducted inside the enclosure. It is assumed that the size of the enclosure would accommodate the required equipment and allow four casks to be removed without moving the enclosure. Excavation would be accomplished by a combination of machine and hand excavation such that each cask can be totally exposed for inspection and proper rigging. The trench will require shoring for personnel protection while preparing the casks for retrieval.

Once the casks have been exposed, they would be banded, rigged, and transferred into an overpack using a mobile crane, or equivalent, still operating within the enclosure. The overpack approach envisioned for this estimate is an overpack that consists of a base plate that the cask can be moved onto, and a dome with an integral lifting fixture that will be placed over the overpack and fastened to the base plate. The overpack would then be lifted out of the trench and staged for loading for transport to the TRU Waste Treatment Facility site. It is assumed that all of the casks will require overpacking.

The dose rate of each cask when placed in the trenches and bunkers was monitored. The dose rate at the surface of the casks ranged from 1 mrem/h to 5,000 mrem/h with approximately 15% of the casks ranging from 1,000 to 5,000 mrem/h. Retrieval would use a staged/graded approach using shielding, distance, and time—depending on the dose rate. Procedures for retrieving casks with larger dose rates would be modified to ensure that worker exposure meets DOE requirements and As Low as Reasonably Achievable (ALARA) objectives.

Routine worker exposures are monitored by dosimeters. Workers are limited to 100 mrem/week and/or 2 rem/year. However, Bechtel Jacobs Company LLC, the on-site contractor, is committed to a dose of less than 1 rem/year for involved workers (Kelley 2000).

Retrieval of Remote-handled TRU Waste Containers from Bunkers

The concrete blocks that enclose the containers in the storage bunkers in SWSA 5 North would be removed to provide access to the casks. The blocks would remain in the bunker for disposition at a later date. Casks have already been palletized and would be ready to be loaded onto the transport trucks with forktrucks.

The waste containers and overpacks would be transported by truck from the trench area and the storage bunker locations to the TRU Waste Treatment Facility site. At least two potential routes have been identified from SWSA 5 North to the TRU Waste Treatment Facility site; one is approximately 0.5 miles, and the other is approximately 1.1 miles. The more conservative assumption of 1.1 miles is used for the calculation of travel distance, and a round trip of 2.2 miles for each load is used.

Transport of Remote-handled and Contact-handled TRU Solid Waste

The number of trips that would be made per day is based on the TRU Waste Treatment Facility site accepting a maximum of 1 cask per day. It is assumed that approximately 200 casks are retrieved from retrievable subsurface storage and 100 casks from storage bunkers. Including the time to build and move the temporary enclosure for the trench excavation as required, and allowing health, safety and inefficiency factors for working in protective clothing inside the enclosure, the total estimated time required to transport all 300 of the remote-handled TRU casks to the TRU Waste Treatment Facility site is approximately 37,000 man-hours. Crew sizes are 10 persons for cask removal and transport of waste from trenches, 8 persons for constructing and moving Rubb tent; and 7 persons for cask removal and transport of waste from bunkers. Assuming 300 round trips for 1 cask per trip, the total mileage for transport of the remote-handled TRU waste to the TRU Waste Treatment Facility site is approximately 660 miles.

There are approximately 60 B-25 boxes and just under 3,000 drums of contact-handled TRU waste stored in aboveground metal buildings. A visual inspection would be made prior to movement of any container to ensure their structural integrity is adequate for them to be moved. It is assumed that 10% of the drums will be deteriorated enough to require overpacking prior to transport. Overpacking could require either placing the drums into commercial overpacks or emptying the waste from the deteriorated drums into the overpacks. For the basis of manhour estimates, it is assumed that all of the deteriorated drums will have to be repackaged into overpacks. The waste in the deteriorated drums would be emptied by hand onto Herculite, or equivalent material, the empty drum placed into the overpack, and the contents then placed into the overpack.

The drums, boxes, and overpacks will be loaded by forktrucks onto a transport truck and transported from the aboveground storage locations to the TRU Waste Treatment Facility site, approximately 1.1 miles away. Based on the assumption that the TRU Waste Treatment Facility site can accept a maximum of 20 each, 55-gal drum-equivalents per day, the 1,000 cubic meters of contact-handled TRU waste would require approximately 7,400 man-hours for a 5-person crew to load, overpack 10% of the waste, and transport waste, and the total mileage is approximately 540 miles. There would be 245 shipments contact-handled waste.

4.8.1.2 Transport from TRU Waste Treatment Facility Site to Interim Storage

For the Treatment and Waste Storage at ORNL Alternative, interim storage is required for all of the waste treated at the TRU Waste Treatment Facility site. Thus, approximately 7,768 m^2 (83,662 ft^2) of additional storage space would have to be constructed, using the Cementation Alternative as the bounding condition. The basis of estimating the transport distance from the TRU Waste Treatment Facility site to interim storage was the assumption that interim storage would be built in SWSA 5 N, which is 1.1 miles from the TRU Waste Treatment Facility site. The basis of the time required to construct interim storage space is that pre-fabricated metal buildings would be used, and administrative controls would be utilized to ensure personnel protection. The estimated time required to construct the 7,768 m^2 (83,662 ft^2) of interim storage is 20,000 hours. The time to load all of the containers of treated waste, transport them to interim storage, and unload them, which is estimated to require 3,339 round trips, is approximately 147,000 hours. Five and one-half full-time equivalents are assumed for the crew size.

Therefore, the total time required for building interim storage space and transporting all of the waste there is 167,000 hours, and the distance required for the transport of the waste containers is 7,346 miles.

4.8.1.3 Off-site Transportation

Methods used to determine off-site transportation impacts for each alternative are discussed below.

- Evaluated the impacts associated with the transportation of TRU waste using the analysis developed for the WIPP SEIS-II (DOE 1997d). Because the packaging requirements and routes are the same, all alternatives involving transportation to the Waste Isolation Pilot Plant in New Mexico would vary only by the number of shipments that would result from the implementation of the alternative.

- Evaluated truck accident statistics for each State, and by highway type. These were used to determine route-specific accident, injury, and fatality rates for the WIPP SEIS-II (DOE 1997d) analysis.

  — Obtained the route mileage through each State using HIGHWAY 3.1 model.

  — Multiplied the mileage by the State traffic, injury, or fatality rates.

  — Summed the products for the route, and divided the sums by the total route mileage.

  — With the exception of the State of New Mexico, the accident rate data for Federally aided interstate highways were used. For the New Mexico routes, the rate for Federally aided primary roads was used since the waste would primarily travel U.S. Highway 285.

  — Multiplied the route-specific accident, injury, and fatality rates by the number of shipments along each route to obtain the estimated number of accidents, injuries, and fatalities.

- Estimated transportation risks for routine operations and accidents were obtained from the WM PEIS (DOE 1997e). These risks were based on State data on the frequency of accidents for trucks per mile traveled. National average rural, suburban, and urban population densities were used. The WM PEIS (DOE 1997e) used an external dose rate of 1 mrem/hour at 1 meter for DOE low-level waste shipments.

- Incorporated analysis for radiological impacts from accidents from two types of analyses conducted for the WIPP SEIS-II (DOE 1997d).

  — The first type of analysis used the RADTRAN code, a model used to compute radiological accident impacts, to estimate the radiological impact from accidents during transport from each of the major DOE sites. This analysis took into account eight different severity categories, their probabilities of occurrence, the distance from each site, and the number of shipments.

  — The second type of accident analysis was an assessment of four bounding accidents. These are described more fully in Appendix E of the WIPP SEIS-II (DOE 1997d). Accident-free radiological impacts due to transportation of the TRU wastes were determined in the WIPP SEIS-II by using the RADTRAN code to estimate the impacts due to this radiation.

- Assumed that all on-site untreated waste shipments to the proposed TRU Waste Treatment Facility would occur on non-public, DOE-controlled roads. The impacts of traffic accidents not related to the radioactive material or hazardous chemicals being transported were assumed to be the same as impacts resulting from the transport of nonhazardous material.

The accident impacts calculated as a number of injuries and fatalities were calculated on a per-shipment basis. Calculations were based on data presented in the WIPP SEIS-II and the WM PEIS (DOE 1997d; 1997e). It was determined that transportation for the entire DOE Waste Management

Program to the Waste Isolation Pilot Plant could account for 56 accidents resulting in 5 fatalities. The ORR portion of this program was calculated as 8.1E-04 accidents per shipment and 1.1E-04 fatalities per shipment, which translates to a possibility that approximately 8 out of 10,000 shipments could potentially result in an accident, with the potential for 1 fatality occurring out of 10,000 shipments. Because the canisters are empty on the return trip, only half of these accidents would occur with a loaded canister. Most transportation accidents are unlikely to cause any radioactive material release, but very severe accidents may result in a release. A 1987 Nuclear Regulatory Commission study, cited in the WIPP SEIS-II (DOE 1997d), estimated that only 0.6% of accidents could cause a radiation hazard to the public.

Analysis of a hypothetical container breach assumed an accident occurred under conditions that maximized, within reasonable bounds, the impacts to exposed populations. The analysis concluded that, for the average concentration of radionuclides and hazardous chemicals in a TRUPACT II waste container, the estimated dose would result in three latent cancer fatalities (LCFs) in the exposed population. The estimated maximum individual dose would result in a 0.04 probability of a LCF. For a breached remote-handled 72B cask, the total population dose estimated would result in a 0.04 LCF in the exposed population. The estimated maximum individual dose would result in a 7E-04 probability of a LCF. Analysis of the ORR to Waste Isolation Pilot Plant route, which included both the probability of an accident and the consequences, estimated a total of 4E-03 LCFs for transuranic waste (WIPP SEIS-II, DOE 1997d).

The major routine risk to the public from truck transportation is from exposure during rest stops to travelers who are using the same rest stops. For the analysis of low-level waste, DOE assumed the average dose rate of each shipment would not exceed 1 mrem/hour at 1 m from the shipping container, which is consistent with DOE’s historical practices. On the basis of typical low-level waste densities, roughly 80 drums with a 208-L (55-gal) capacity would be shipped per truck. The dose per shipment of low-level waste is estimated to be the same for all alternatives involving transportation. The dose to a MEI stuck in traffic for 30 minutes next to a low-level waste shipment is estimated to be 0.5 mrem, representing a lifetime risk of fatal cancer of 3.0E-07 (based on International Commission on Radiological Protection Publication 60 health risk conversion factors).

An accident of severity Category VIII was used to calculate the exposure to the public in the event of an accident. A Category VIII accident represents the most severe accident scenario and assumes the maximum magnitude of mechanical forces (impact) and thermal forces (fire) to which a waste package may be subjected during a truck accident. It would result in the largest releases of radioactive material. Accidents of this severity are extremely rare, occurring once in every 70,000-truck accidents. On the basis of national accident statistics (Saricks and Kvitek 1994) for every 1.6 km (1 mile) of shipment (loaded), the probability of an accident of this severity is 6E-12. The WM PEIS (DOE 1997e) assumed the route distance from the ORR to the Nevada Test Site was 2,151 miles. Thus, for each shipment to the Nevada Test Site, the probability of an accident of this severity is 1.3E-08. DOE concluded that no accident of such severity is expected to occur for the WM PEIS waste alternatives . The estimated consequences for this improbable accident are given in Table 4-8. Because a waste with the highest transportation accident dose was used in the analysis, the accident consequence results are extremely conservative. These results are at least a factor of 10 greater than those anticipated for ORNL low-level waste shipments (DOE 1997e).

Table 4-8. Estimated consequences for the most severe accidents involving shipments of low-level waste[a]

	Population		Maximally exposed individual	
	Dose (rem)	Risk (cancer fatalities)	Dose (rem)	Risk (cancer fatalities)
	Accident location (neutral conditions)			
Urban	8.3E+03	4.2E+00	7.7E-01	3.9E-04
Suburban	1.6E+03	8.0E-01	7.7E-01	3.9E-04
Rural	1.5E-01	8.0E-03	7.7E-01	3.9E-04

[a]Data taken from WM PEIS (DOE 1997e).

4.8.2 No Action Alternative

There would be no transportation of wastes under the No Action Alternative; therefore, no transportation impacts would occur.

4.8.3 Low-Temperature Drying Alternative

4.8.3.1 Waste Retrieval and On-site Transportation

Waste retrieval activities during the Low-Temperature Drying (and other) alternatives consist of exhuming 200 remote-handled waste containers from the SWSA 5 North trenches, removing 100 remote-handled waste containers from the SWSA 5 North aboveground bunkers and buildings, removing 5,000 55-gal drum equivalents of contact-handled waste from the buildings, and loading the containers on trucks. The containers would then be transported an average of approximately 1.1 miles to the treatment facility where they are unloaded within the facility. The retrieval activities at the trenches would be conducted within a temporary, negative-pressure enclosure with a HEPA-filtered exhaust. Workers within the enclosure are required to have suitable protective clothing and equipment with workplace monitoring to ensure radiological doses are within DOE and site guidelines and meet ALARA objectives.

The hazards of waste container retrieval and transportation operations include radioactive doses to facility workers during normal operations, radioactive doses to workers and the public due to facility accident releases, and non-radiological industrial accident and truck transportation accident consequences. In general, radiological doses to facility and transportation workers are controlled by protective clothing, distance from the source, shielding if required, equipment, and by DOE operating procedures. These procedures include requirements to promptly evacuate the immediate vicinity of an accident until the safety of reentering the area is evaluated. The consequences of these low-level doses to facility workers are not separately evaluated in this analysis. Risks to facility workers are bounded by industrial accident consequences. The radiological and non-radiological consequences of retrieval and transportation accidents are evaluated in the following paragraphs and in Table 4-15.

Waste Retrieval Accidents and Routine Exposures

The principal accidents expected to occur during the retrieval phase are container drop accidents, vehicle impact accidents, vehicle impact and consequential fire accidents, and general industrial accidents. Vehicle impact and container drop accidents may result in a release of radioactive material within the enclosure. However, non-involved workers and the public outside the enclosure are protected since the enclosure and the filtration system confine the released material. Within the enclosure, workers are protected by safety equipment and evacuation requirements.

A vehicle impact causing release of radioactive materials and a fire affecting these materials could burn through the enclosure releasing the suspended radionuclides to the environment. The frequency and consequences of this accident have been evaluated in Section 4.11.6. The accident is estimated to occur in the 1E-04 to 1E-06/year frequency range. A non-involved (and unprotected) worker postulated to be 80 m from the release is estimated to receive a dose of 30 rem resulting in a 1.2E-02 probability of a latent fatal cancer (LCF). A public MEI at the site boundary is estimated to receive a dose of 0.28 rem resulting in a 1.4E-04 probability of LCF. The surrounding population within 50 miles of the release receives a total dose of 4,300 person-rem resulting in 2.1 LCF. Since the unsheltered on-site worker population is sparse, the worker population dose has not been separately estimated. However, consequences to the worker populations are included in the overall population dose consequence.

In addition to the radiological consequences, industrial accidents contribute to non-radiological impacts to workers. As listed in Section 4.8.1.1, a total of 44,400 person-hours are required to retrieve, load, and transport the contact-handled and remote-handled wastes. Based on a DOE industrial fatality rate of 3.4E-03 fatalities per 200,000 person-hours, 7.5E-04 fatalities are expected over the retrieval operations.

Routine exposure to involved workers would be controlled by DOE and Bechtel Jacobs procedures (Section 4.8.1.1). Workers constructing the Rubb tent are assumed not to be exposed. Assuming ten on-site workers full-time for waste retrieval operations and an exposure of less than 1 rem/year yields 10 rem/year to the involved workers. The worker exposure rate is 4.0E-04 LDFs/rem and the retrieval operations are estimated at two years. This yields 8.0E-03 LCFs for involved workers.

Waste Transportation Accidents

Large truck accidents sufficiently severe to release radioactive materials from containers are postulated to occur during transport of wastes to the treatment facility. Fatal large truck accidents are postulated to occur during transport to the treatment facility or during the return trip. The one-way mileage (270 miles) for contact-handled and remote-handled (330 miles) waste transport is estimated to be 600 miles as discussed in Section 4.8.1.1. One-way mileage is used when computing radiological accidents because waste (and thus accident risk) is hauled one way from the SWSA 5 North area to the treatment facility.

For off-site transportation of wastes to a disposal site (Section 4.8.3.2), a maximum-severity large truck highway accident is estimated to occur at a rate of 6E-12/vehicle-mile. However, for this on-site transportation evaluation, a fatal large truck highway accident is conservatively postulated to result in waste container failure and fire. Based on *Large Truck Crash Profile: The 1998 National Picture*, prepared by the Federal Motor Carrier Safety Administration, large truck fatal accidents occur at a rate of 2.3E-08/vehicle-mile. Based on this rate, 1.4E-05 accidents resulting in radioactive material release and fire and 2.8E-05 fatal accidents are expected to occur over the entire waste transportation operation.

The radiological consequences of waste transportation accidents are the same as those defined for the vehicle impact and fire accident during the retrieval operations. In addition, 1.2 fatalities are estimated to occur for each fatal large truck accident. This results in 3.3E-05 non-radiological fatalities occurring over the waste transportation operation.

Summary of Retrieval and On-site Transportation Risks

Accident risk is defined as the product of the likelihood of an accident and the consequence per accident. The industrial accident and fatal truck accident estimates incorporate both likelihood and consequence and are risk measures. The total frequency of the vehicle impact and fire accident during retrieval is estimated to be 3E-05 based on the median frequency in the estimated range and a 3-year duration of operations. The accident risks and routine worker exposure risks are summarized below:

Accident/Consequence	Accident Risk (expected fatalities)
Retrieval Accidents	
Radiological	6.3E-05 LCF (public)
Non-radiological (Industrial)	7.5E-04 fatalities (involved workers)
Transportation Accidents	
Radiological	2.9E-05 LCF (public)
Non-radiological	3.3E-05 fatalities
Routine Exposure	**Accident Risk (expected fatalities)**
Waste Retrieval Operations	8.0E-03 LCF (involved workers)

The total risks to the non-involved worker and the public MEI at the site boundary due to both retrieval and transportation accidents are 5.3E-07 and 6.2E-09 probabilities of cancer fatality. These risks are small with respect to the risks summarized above.

4.8.3.2 Off-site Transportation

There would be an estimated 397 shipments of TRU waste to the Waste Isolation Pilot Plant resulting from the implementation of the Low-Temperature Drying Alternative.

Non-radiological effects of TRU waste shipments: The shipment of TRU waste would result in 1.7E-03 LCFs attributed to pollution health effects from the truck emissions. The WIPP SEIS-II (DOE 1997d) stated the probability of an accident as 8.1E-4 per shipment and the probability of a fatality as 1.1 E-04 per shipment. This would yield a calculated probability of 3.2 E-01 for accidents and a 4.4E-02 probability of a fatality associated with the TRU shipments for the Low-Temperature Drying Alternative.

Radiological effects of TRU waste shipments: Table 4-9 presents the calculated total population LCFs for the waste shipment to Waste Isolation Pilot Plant resulting from the implementation of the Low-Temperature Drying Alternative.

Table 4-9. Calculated non-accident radiological LCFs for the Low-Temperature Drying Alternative[a]

Oak Ridge to Waste Isolation Pilot Plant	Contact-handled TRU waste shipments (87)	Remote-handled TRU waste shipments (310)
LCFs	8.7E-03	3.1E-02

[a]Data in table were derived from exposure/shipment data presented in the *Waste Isolation Pilot Plant Disposal Phase Final Supplemental Environmental Impact Statement* (WIPP SEIS) (DOE 1997d).
LCFs = latent cancer fatalities.
TRU = transuranic.

Non-radiological effects of low-level waste shipments: The WM PEIS estimated fatalities with shipments of low-level waste as approximately one fatality per 16 million shipment miles. Using a representative route distance of 2,151 miles from Oak Ridge to the Nevada Test Site, there would be an estimated 1.3 E-04 fatality per shipment. The Low-Temperature Drying Alternative represents 277 low-level waste shipments or 2.6E-01 accidents and 3.6E-02 accident fatalities.

Radiological effects of low-level waste shipments: The 277 shipments for this alternative represent a dose of 4.3E-06 person-rem and LCFs of 2.1E-09. The final waste disposal facility for low-level waste is consistent with the Nevada Test Site selected in the *Record of Decision for the Department of Energy's Waste Management Program: Treatment and Disposal of Low-level and Mixed Low-level Waste; Amendment of the Record of Decision for the Nevada Test Site* (DOE 2000).

DOE would perform comprehensive waste certification before disposition of the waste to any disposal site. For each waste stream, the specific waste profile would be prepared in sufficient detail to provide reasonable assurance that the intended waste product, packaging, documentation, and shipping schedule meet the disposal site requirements and capacity. Table 4-10 shows the projected shipping schedule of waste for the Low-Temperature Drying Alternative. In nearly all cases, the waste generation projected for the Low-Temperature Drying Alternative is a small fraction of the disposal facility's capacity, or acceptance rate, for these wastes. The current national TRU program planning document anticipates, that the ORR would ship almost 16% of the total shipments of the remote-handled TRU waste to be disposed at the Waste Isolation Pilot Plant (DOE 1997d). The waste stream that demands the highest percentage of repository capacity from this alternative is the remote-handled TRU waste, and the projected number of shipments amounts to approximately 4% of the waste to be disposed of at the Waste Isolation Pilot Plant over the next 35 years.

The packaging and transportation equipment needed for safe transport is available to support the projected generation of all wastes. For example, the highest anticipated project usage rate for contact-handled TRU transport casks (TRUPACT II) is 70% of the casks made available to the ORR for this purpose (for only a 5-month period). Maximum demand for remote-handled TRU transport casks (72B) is only 35% of the casks available to the ORR for this purpose. The same is true for the low-level waste shipments projected from the facility; approximately 10% of the casks available commercially in the United States for this type of waste would be committed for approximately a 2-year period.

Table 4-10. Projected waste shipment schedule for the Low-Temperature Drying Alternative

	Calendar year and month																																						
	2003												**2004**												**2005**												**2006**	**2007**	
	J	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**	**Total**	**Total**	**Total**
Waste Isolation Pilot Plant shipments																																							
72B Cask shipping container:																																							
Treated TRU sludge shipments	12	11	12	11	12	11	12	11	12	11	12	6	12	11	12	11	12	9																					200
Treated RH TRU solids shipments													2	3	3	3	3	3	3	3	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	36	7[a]	110
Total	12	11	12	11	12	11	12	11	12	11	12	6	14	14	15	14	15	12	3	3	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	36	7	**310**
TRUPACT II shipping container:																																							
Nuclear Fuel Services Drum shipments													12	13	13	13	8																						59
CH TRU solids shipments													1	2	2	2	2	2	2	2	1	1	1	1			1			1			1			1	4	1	28
Total													13	15	15	15	10	2	2	2	1	1	1	1			1			1			1			1	4	1	**87**
Total TRU Shipments													27	29	30	29	25	14	5	5	3	3	3	3	3	3	4	3	3	4	3	3	4	3	3	4	40	8	***397***
Nevada Test Site shipments*																																							
Treated low-level supernate shipments, (208 ft^3 liners)	4	5	4	5	4	5	4	5	4	5	4	2	5	5	5	5	5	5	10	10	10	8																	119
Low-level waste solids shipments (compacted empty casks)													1	2	2	3	3	4	4	4	4	4	4	3	4	4	4	3	4	4	4	3	4	4	4	3			139
Other secondary waste shipments		1		1		1		1		1		1		1		1		1		1		1		1				1					1			1			19
Total low-level waste shipments	4	6	4	6	4	6	4	6	4	6	4	3	6	8	7	9	8	10	14	15	14	13	4	4	4	4	4	4	4	4	4	3	5	4	4	4			***277***
Total all shipments																																							**674**

[a]Pattern unchanged through February 2007, with remainder in March 2007.

*The final waste disposal facility for low-level waste will be consistent with the Record of Decision of the WM PEIS for low-level waste (e.g., the Nevada Test Site or another designated disposal facility).

RH = Remote-handled.

CH = Contact-handled.

The largest volume of locally disposed material, approximately 5,500 m^3 of concrete rubble from the facility demolition, equates to approximately 275 truckloads over a removal period of several weeks. This demand is easily satisfied by local transportation contractors. The handling and transportation systems necessary to remove and transfer the remaining project waste streams are common commercial equipment, readily available and entirely adequate to satisfy the needs of this alternative.

4.8.4 Vitrification Alternative

4.8.4.1 Waste Retrieval and On-site Transportation

The impacts would be identical to those described for the Low-Temperature Drying Alternative in Section 4.8.3.1.

4.8.4.2 Off-site Transportation

Non-radiological effects of TRU waste shipments: The Vitrification Alternative would result in an estimated 989 shipments of TRU waste. The pollution health effects resulting from vehicle emissions are determined to be 4.4E-03 LCFs, with an estimated 8.0E-01 accidents and 1.1E-01 fatalities.

Radiological effects of TRU waste shipments: Table 4-11 presents the LCFs calculated for the representative Oak Ridge to Waste Isolation Pilot Plant route, based on 989 shipments.

Table 4-11. Calculated non-accident radiological LCFs for the Vitrification Alternative[a]

ORNL to Waste Isolation Pilot Plant	Contact-handled TRU waste shipments (53)	Remote-handled TRU waste shipments (936)
LCFs	5.3E-03	9.3E-02

[a]Data in table were derived from exposure/shipment data presented in the *Final Waste Isolation Pilot Plant Disposal Phase Supplemental Environmental Impact Statement* (WIPP SEIS) (DOE 1997d).

LCFs = latent cancer fatalities.

TRU = transuranic.

Non-radiological effects of low-level waste shipments: The effects of the transportation of low-level waste for the Vitrification Alternative are estimated as 281 shipments resulting in an estimated 2.6E-01 accidents and 3.6E-02 accident fatalities.

Radiological effects of low-level waste shipments: The 281 shipments correspond to a cumulative dose of 4.4E-06 rem to a person living along the ORR site entrance route. This represents a negligible lifetime risk (probability of cancer fatality) of 2.1E-09 for this alternative.

The waste stream that demands the highest percentage of repository capacity among any of the disposal pathways identified is the remote-handled TRU waste treated and packaged by the Vitrification Alternative. The projected shipments amount to approximately 12% (instead of the presently planned 16%) of this type of waste to be disposed at the Waste Isolation Pilot Plant over the next 35 years (DOE 1997d). The packaging and transportation equipment needed to effect the safe transport is available to support the projected generation of all wastes. For example, the highest anticipated project usage rate for contact-handled TRU transport casks (TRUPACT II) is 20% (approximately 1 shipment/week) of the casks made available (5 shipments/week) for this purpose (for a 16-month period). However, the minimal demand over the 3-year operating period for remote-handled TRU transport casks (72B) is 65% to 70% of the casks made available (8 casks/week) to the ORR (over a period of 1 year), while the maximum demand is 100% of the casks available to the ORR (over a period of 1.5 years). Evaluation of the low-level waste shipments projected from the Vitrification Alternative facility indicates approximately 5% of the casks available commercially in the United States for this type of waste would be committed for approximately a 1-year period.

Shipping operations for this alternative are planned to require single-shift, 5-day-per-week operation. Since there is 100% utilization of available casks for a period of 1.5 years, it is likely that some of the processed waste would have to be shipped during the D&D phase of this alternative.

The largest volume of locally disposed material, approximately 21,000 m^3 of concrete rubble from the facility demolition, equates to approximately 1,250 truck loads over a period of several months. This demand is easily satisfied by local transportation contractors. The handling and transportation systems necessary to remove and transfer the remaining project waste streams are common commercial equipment, readily available and entirely adequate to satisfy the project's needs.

Construction traffic transportation impacts for the Vitrification Alternative are similar to those discussed for the Low-Temperature Drying Alternative (peak construction traffic is increased due to 2.5 times more workers than the Low-Temperature Drying Alternative), only the following transportation impacts are discussed in this section.

- Operations traffic impacts
  - — waste transfers to the facility from ORR;
  - — treated waste shipments; and
  - — worker and operations-related traffic; and

- D&D traffic impacts.

Waste shipments of treated primary waste products from the Vitrification Alternative facility would occur over a 3-year period. Table 4-12 provides the waste shipment schedule for the Vitrification Alternative.

The D&D phase of the project is expected to begin in 2006 and extend for 2 years. The D&D traffic profile would be similar to the construction phase of the project, although reversed. Worker traffic would be approximately one-half to a one-third the peak construction force, reducing in later stages. Truck traffic would peak to several 15.3-m^3 (60-ft^3) debris hauls per day midway through the D&D period.

Table 4-12. Projected shipment schedule for the Vitrification Alternative

	2003												**2004**												**2005**												**2006**	**2007**	
	J	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**	**Total** [g,h]	**Total** [g,h]	**Total**
Waste Isolation Pilot Plant shipments																																							
72B Cask shipping container:																																							
Treated TRU sludge & supernate[a]				22	22	22	22	22	22	22	22	20	22	22	22	22	22	22	22	22	22	22	22	20	22	22	22	22	22	22	22	22	22	22	22	22			722
Treated RH TRU solids[b]																11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	4					202
D&D waste[c]																																					9	3	12
Total	0	0	0	22	22	22	22	22	22	22	22	20	22	22	22	33	33	33	33	33	33	33	33	31	33	33	33	33	33	33	33	33	33	26	22	22	9	3	**936**
TRUPACT II shipping container:																																							
CH solids[d]	2	3	4	3	4	3	4	3	4	3	4	3	4	3	4	2																							**53**
Total TRU shipments																																							***989***
Nevada Test Site shipments*																																							
RH low-level waste solids[e]																						2	2	2	2	2	2	2	2	2	2	2	2	2	1				27
Low-level waste solids[f]	2	4	4	3	3	4	3	3	4	3	3	4	3	3	4	3	3	4	3	3	4	3	3	4	3	3	4	3	3	4	3	3	4	3	3	4	96	38	254
Total low-level waste	2	4	4	3	3	4	3	3	4	3	3	4	3	3	4	3	3	4	3	3	4	5	5	6	5	5	6	5	5	6	5	5	6	5	4	4	96	38	***281***
Total all shipments																																							**1,270**

Notes:

*The final waste disposal facility for low-level waste will be consistent with the Record of Decision of the WM PEIS for low-level waste (e.g., the Nevada Test Site or another designated disposal facility).

[a]The sludge and supernate are put into HalfPACTs and then two HalfPACTs are placed into a 72B Cask. Each HalfPACT contains 0.4 m^3 of treated waste.

[b]Remote-handled (RH) solids that are being shipped to the Waste Isolation Pilot Plant are put into 55-gal drums which are then put into an RH Canister that is then placed in a 72B Cask.

[c]The decontamination and decommissioning (D&D) waste would be directly put into an RH Canister that would be placed into a 72B Cask.

[d]Contact-handled (CH) solids that are being shipped to the Waste Isolation Pilot Plant are put into 55-gal drums which are then put into a TRUPACT II. Although it is possible to have 14 drums per TRUPACT II and 3 TRUPACT II containers per shipment, it was assumed that only eight 55-gal drums could be placed into a TRUPACT II based upon weight limitations.

[e]RH low-level waste would be shipped in a Super Tiger shipping container, which limits the number of drums per shipment to 16.

[f]Other non-RH low-level waste would be shipped without a special shipping container, which would allow eight 55-gal drums per shipment.

[g]There would be approximately one 72B cask shipment per month from April 2006 to March 2007.

[h]There would be 8 Nevada Test Site shipments/month for the first 14 months in D&D, and then there would 6, 6, 5, and 5 shipments. All low-level waste shipments should be completed by June 2007.

RH = Remote-handled.

CH = Contact-handled.

4.8.5 Cementation Alternative

4.8.5.1 Waste Retrieval and On-site Transportation

The impacts would be identical to those described for the Low-Temperature Drying Alternative in Section 4.8.3.1.

4.8.5.2 Off-site Transportation

Non-radiological effects of TRU waste shipments: The Cementation Alternative is predicted to involve 2,425 shipments of TRU waste. This exceeds the total number of shipments to the Waste Isolation Pilot Plant from ORR as proposed in the WIPP SEIS-II and would result in 2.2 accidents and 3.0E-01 fatalities. The pollution health effects are estimated at 1.2E-02 LCFs due to transportation of the waste.

Radiological effects of TRU waste shipments: Table 4-13 presents the LCFs calculated for the representative Oak Ridge to the Waste Isolation Pilot Plant route.

Table 4-13. Calculated non-accident radiological LCFs for the Cementation Alternative[a]

ORNL to Waste Isolation Pilot Plant	Contact-handled TRU waste shipments (53)	Remote-handled TRU waste shipments (2,372)
LCFs	5.3E-03	2.7E-01

[a]Data in table were derived from exposure/shipment data presented in the *Waste Isolation Pilot Plant Disposal Phase Final Supplemental Environmental Impact Statement* (WIPP SEIS)(DOE 1997d).
LCFs = latent cancer fatalities.
TRU = transuranic.

Non-radiological effects of low-level waste shipments: The Cementation Alternative would result in 914 shipments of low-level waste and an estimated 8.8E-01 accidents and 1.2E-01 accident fatalities.

Radiological effects of low-level waste shipments: The potential cumulative dose to a person living along the ORR site entrance route for this alternative is estimated as 1.5E-05 person-rem corresponding to a calculated 7.5E-09 LCF.

The waste stream that demands the highest percentage of repository capacity among any of the disposal pathways identified is the remote-handled TRU waste packaged by the Cementation Alternative. The projected shipments amount to approximately 30% (instead of the presently planned 16%) of this type of waste to be sent to and disposed at the Waste Isolation Pilot Plant over the next 35 years (DOE 1997d). This amount of waste would greatly impact the Waste Isolation Pilot Plant remote-handled disposal capacity.

The packaging and transportation equipment needed to effect safe transport is available to support the projected generation of all wastes. For example, the highest anticipated project usage rate for contact-handled TRU transport casks (TRUPACT II) is 10% (approximately 5 shipments/week) of the casks made available for this purpose (for a 33-month period). However, the demand over the 6-year operating period for remote-handled TRU transport casks (72B) is 95% of the casks made available (8 casks/week) to the ORR. Evaluation of the remote-handled low-level waste shipments projected from the Cementation Alternative facility indicates approximately 70% of the casks currently available commercially in the United States for this type of waste would be committed for approximately a 6-year period. This is a significant resource use.

Calculations show that the average TRU concentration for the treated sludge is between 200 and 300 nanocuries per gram which indicates that, due to the high variability in the concentration in the waste, it is likely that there could be treated waste that is not TRU. An alternative approach for treatment, which affects transportation, would be to directly fill remote-handled canisters instead of 55-gal drums for the cementation process. If this were done, the total number of remote-handled shipments would decrease to approximately 1,750 shipments. This would allow the treatment schedule to be reduced to 5 years (from 6 years).

Shipping operations are planned to require single-shift, 5-day-per-week operation. However, due to the increased number of shipments on a weekly basis over the Low-Temperature Drying Alternative, it is likely that shipping operations would extend to two shifts or would be conducted in a shift different from operations, or both.

The largest volume of locally disposed material, approximately 14,000 m^3 (45,932 ft^3) of concrete rubble from the facility demolition, equates to approximately 850 truck loads over a period of several months. This demand is easily satisfied by local transportation contractors.

Since the construction traffic transportation impacts for the Cementation Alternative are similar to the Low-Temperature Drying Alternative, only the following transportation impacts are discussed in this section.

- Operations traffic impacts due to
  - waste transfers to the facility;
  - treated waste shipments;
- D&D traffic impacts.

Waste shipments of waste products from the proposed facility would occur over a 6-year period. Table 4-14 provides the waste shipment schedule for the Cementation Alternative.

The D&D phase for the Cementation Alternative is expected to begin in 2009 and extend for 2 years. The D&D traffic profile would be approximately three times the profile of the Low-Temperature Drying Alternative. Truck traffic would peak to several 15.3 m^3 (20 yd^3) debris hauls per day during the first year in the D&D period.

4.8.6 Treatment and Waste Storage at ORNL Alternative

4.8.6.1 Waste Retrieval, On-site Transportation, and Interim Storage[1]

For the Treatment and Waste Storage at ORNL Alternative, the consequences and risks of waste retrieval and transportation to the treatment facility are the same as for the Low-Temperature Drying Alternative (Section 4.8.3.1). In addition, hazards are encountered due to the transportation of treated wastes to the interim storage facility and the industrial hazards of constructing the interim storage

[1]The 147,000 man-hours for loading and unloading the treated waste are included. In addition, the 20,000 man-hours needed to construct the interim storage facilities are included in "Interim Storage."

Table 4-14. Projected shipment schedule for the Cementation Alternative

	2003				**2004**				**2005**				**2006**				**2007**				**2008**				
	1	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**Total**
Waste Isolation Pilot Plant shipments																									
72B cask shipping container:																									
Treated TRU sludge[a]	99	99	99	99	99	99	99	99	99	99	85	85	85	85	85	85	85	85	85	85	85	85	80	80	2170
RH TRU solids[b]											14	14	14	14	14	14	14	14	14	14	14	14	17	17	202
Total	99	99	99	99	99	99	99	99	99	99	99	99	99	99	99	99	99	99	99	99	99	99	97	97	***2,372***
TRUPACT II shipping container:																									
CH solids[c]	3	5	5	5	5	5	5	5	5	5	5														53
Total TRU shipments	102	104	104	104	104	104	104	104	104	104	104														***2,425***
Nevada Test Site shipments*																									
Treated RH low-level solids[d]															3	3	3	3	3	3	3	3	3		27
Treated low-level supernate[e]	32	32	33	33	33	33	33	33	33	33	32	32	32	32	32	32	32	32	32	32	32	32	32	32	776
Low-level waste solids[f]	2	3	3	2	2	3	3	2	2	3	7	6	7	7	7	6	7	8	7	6	7	7	2	2	111
Total low-level waste	34	35	36	35	35	36	36	35	35	36	39	38	39	39	42	41	42	43	42	41	42	42	37	34	***914***
Total all shipments																									**3,339**

Notes:
*The final waste disposal facility for low-level waste will be consistent with the Record of Decision of the WM PEIS for low-level waste (e.g., the Nevada Test Site or another designated disposal facility).
[a]The sludge is put into a 50-gal liner, overpacked into a 55-gal drum, and then 3 55-gal drums are placed into a remote-handled (RH) canister and then a 72B Cask.
[b]Solids that are being shipped to the Waste Isolation Pilot Plant are put into 55-gal drums and three 55-gal drums are put into an RH canister and then a 72B Cask.
[c]Contact-handled (CH) solids that are being shipped to the Waste Isolation Pilot Plant are put into 55-gal drums, which are then put into a TRUPACT II. Although it is possible to have 14 drums per TRUPACT II and 3 TRUPACT II containers per shipment, it was assumed that only eight 55-gal drums could be placed into a TRUPACT II based upon weight limitations.
[d]RH low-level waste would be shipped in a Super Tiger (or similar) shipping container, which limits the number of drums per shipment to 16.
[e]The supernate is put into a 50-gal liner, overpacked into a 55-gal drum, and then placed into a Super Tiger (or similar shipping container).
[f]Other non-RH low-level waste would be shipped without a special shipping container, which would allow eighty 55-gal drums per shipment.

facility. In contrast to retrieval and initial transportation operations, the treated wastes are considered non-combustible and essentially non-dispersible. Therefore, the radiological consequences of these treated waste operations are negligible.

Using the cementation process as the bounding case, a total of 7,346 additional miles (3,339 miles roundtrip) will be traveled to transport the treated wastes to the interim storage facility. Based on the large truck fatal accident data used in Section 4.8.3.1, this operation results in an additional 2.0E-04 expected fatalities. An additional 147,000 person-hours would be required to load and unload the treated wastes, and 20,000 person-hours will be required to construct the interim storage facility. This labor results in a total of 2.8E-03 expected additional fatalities based on an industrial accident fatality rate of 3.4E-03 fatalities per 200,000 person-hours. The total risks of retrieving and transporting treated and untreated wastes, and storing the treated wastes are summarized in Table 4-15:

Table 4-15. Summary of Treatment and Waste Storage at ORNL Risks

Shipments	
Untreated waste shipments to the treatment facility	▪ 300 remote-handled shipments, and ▪ 250 contact-handled shipments
Treated waste shipments to interim onsite storage	▪ 3,339 shipments (cementation process assumed as bounding case)
Non-radiological effects	
Exposure/Accident	**Risk (expected fatalities)**
Industrial accidents during waste retrieval operations	7.5E-04 fatalities (involved workers)
Routine exposures during waste retrieval operations	8.0E-03 LCFs (involved workers)
Transportation accidents	2.3E-04 fatalities
Construction of interim storage facilities (industrial)	3.4E-04 fatalities (involved workers)
Loading and unloading of treated waste accidents	2.5E-03 fatalities (involved workers)
Radiological effects	
Exposure/Accident	**Risk (expected fatalities)**
Retrieval accident (vehicle impact/fire)	6.3E-05 LCF (public)
Transportation accident (vehicle impact/fire)	2.9E-05 LCF (public)

The risks to non-involved workers and the MEI at the site boundary are the same as those listed for the Low-Temperature Drying Alternative, Section 4.8.3.1.

4.8.6.2 Off-site Transportation

The Treatment and Waste Storage at ORNL Alternative does not involve the shipment of any TRU or low-level wastes offsite and would have no off-site transportation effects.

4.8.7 Transportation Impacts Summary

Waste retrieval would result in 6.E-05 LCFs to the public from a fire-related accident releasing radionuclides. Involved workers at SWSA 5 North during waste retrieval operations would experience 7.5E-04 industrial fatalities. An additional 2.3E-04 transportation fatalities and 2.9E-05 LCFs to the public from transportation-related accidents are expected during onsite transportation. These results are expected for all four action alternatives. For the Treatment and Waste Storage at ORNL Alternative, there are additional risks to workers from both the construction of an interim storage facility

(3.4E-04 fatalities) and from the loading and unloading of treated wastes (2.5E-03 fatalities), plus a larger onsite transportation accident risk (2.3E-04 fatalities) than the other action alternatives.

There would be no off-site transportation of TRU and low-level waste for the No Action and the Treatment and Waste Storage at ORNL Alternatives. A comparison of the Low-Temperature Drying, Vitrification, and Cementation Alternatives with regard to radiological and non-radiological effects of TRU and low-level waste shipments is presented in Table 4-16. As described in this table, the non-radiological probability of a fatality for shipment of TRU waste to the Waste Isolation Pilot Plant ranges from 4.4E-02 (Low-Temperature Drying Alternative) to 3.0E-01 (Cementation Alternative). The probability of a fatality due to the shipment of low-level waste to the Nevada Test Site was determined as a miles-traveled proportion of the national low-level waste program. Because cementation would result in more shipments of low-level waste, this alternative represents the highest probability of a non-radiological fatality, 1.2E-01.

Table 4-16. Comparison of alternatives (calculated transportation accidents/fatalities based on total off-site shipments)

Alternative	**No Action Alternative; Treatment and On-site Storage at ORNL Alternative**	**Low-Temperature Drying Alternative**		**Vitrification Alternative**		**Cementation Alternative**	
Waste type		**TRU**	**LLW**	**TRU**	**LLW**	**TRU**	**LLW**
Shipments	No off-site shipments	397	277	989	281	2,425	914
			Non-radiological effects				
Probability of an accident[a,b]		3.2E-01		8.0E-01		2.2	
Fatality due to non-radiological accident		4.4E-02[a]	3.6E-02[b]	1.1E-01[a]	3.6E-02[b]	3.0E-01[a]	1.2E-01[b]
Pollution effects (public LCFs due to truck emissions)[a]		1.7E-03		4.4E-03		1.2 E-02	
			Radiological effects to the public				
Dose (person-rem)		17.4 (CH) 62 (RH)		10.6 (CH) 180 (RH)		10.6 (CH) 540 (RH)	
Dose (rem)			4.3E-06[c]		4.4E-06[c]		1.5E-05[c]
LCF		8.7E-03 (CH) 3.1E-02 (RH)	2.1 E-09	5.3E-03 (CH) 9.3E-02 (RH)	2.1E-09	5.3E-03 (CH) 2.7E-01 (RH)	7.5E-09

[a] Analysis used route to Waste Isolation Pilot Plant.
[b] Calculated by mileage ratio.
[c] Dose to person at Oak Ridge Reservation site entrance.

LLW = low-level waste.
LCF = latent cancer fatalities.
ORNL = Oak Ridge National Laboratory.
CH = contact-handled.
RH = remote-handled.
TRU = transuranic.

In general, the radiological risks from routine transportation of radioactive materials are directly proportional to the external dose rate. Dose rates to the public are low and would typically be less than that of natural background radiation. The calculated LCFs for both TRU and low-level waste are shown in Table 4-16. TRU waste has been divided into contact-handled and remote-handled in the table.

4.9 UTILITY REQUIREMENT IMPACTS

This section discusses the impacts of the alternatives on utilities. There is currently 500 kW of electrical power available from the utilities lines in the vicinity of the proposed TRU Waste Treatment Facility Site. A 30-cm (12-inch) potable water main is available near the proposed facility for use. It is assumed for each alternative that involves waste treatment, that potable water, electricity, and telephones would be connected to sources on the adjacent Melton Valley Storage Tank facilities or other nearby locations. Water would be supplied for drinking, process needs, sanitation, and fire protection from the nearby water main. Electricity would be used for heating, lighting, and operations. Telephone service would be required for operations.

4.9.1 Methodology

The methods used to determine the utility requirement impacts for each alternative are listed below.

- Determined the projected electrical requirements for each alternative.
- Determined project water usage for each alternative.

4.9.2 No Action Alternative

The energy requirements associated with the No Action Alternative for continued storage of the waste are limited to the power demands associated with the operation of facility lighting, ventilation, and security systems. The annual energy-related usage resulting from the operation of these systems at the current waste storage facilities ranges from 12 to 32 MW. Using an assumed mid-point for the usage, the total power usage for the lifetime of this alternative (100 years) is estimated at 2,200 MW.

The No Action Alternative would not require the use of any groundwater. Water for drinking, sanitation, and fire protection would continue to be used at present levels. Water use for continued storage is minimal compared to the water availability and current uses in the Melton Valley area at ORNL and the ORR. Water use is estimated to be less than 200 gal per day for the current storage facilities. This is based on the use of 50 gal per non-resident worker per day (FTH EIS 1999), and approximately 3.5 full-time equivalent workers, working 5 days per week, stationed at the Melton Valley Storage Tanks, and the existing solid waste storage facilities (Roy 2000, personal communication). The implementation of the No Action Alternative would result in the continued use of approximately 50,000 gal of water per year, or 5 million gal over the assumed 100-year institutional control period.

4.9.3 Low-Temperature Drying Alternative

Utility requirements during construction, operations, and D&D activities of a low-temperature drying waste treatment facility are summarized in Table 4-17. These utilities would be used throughout the life of the Low-Temperature Drying Alternative, but peak loads and the highest average utilization would occur during the 2 years of projected tank waste retrieval and treatment operations (i.e., 2003–2004).

The available electrical service at the treatment facility site is limited to 500 kW, but at least one source for the additional 2.1-MW peak demand from the facility systems is located less than a mile from the facility (Figure 4-2). An aboveground power line would be installed as part of the project to provide the additional power required for the proposed facility. DOE has evaluated the proposed extension and connection of the proposed load at this point in its distribution system. It requires only a routine emplacement of poles and cable along the existing patrol road right-of-way to accomplish this effort. Projected use of 2.6 MW is unlikely at any one time for the Low-Temperature Drying Alternative; however, if it were to occur, it would only be approximately 2% of the current ORR load. The conversion and dissipation of this electrical energy would be primarily to heat energy, both latent (in the form of evaporated water) and sensible (warmed air emitted from the building stack). Estimated electrical usage is based on the treatment process and mass balances computed in Appendix B. Total electrical usage is estimated at 15,000 MW. Considering the ORR's total energy input, the facility's contribution to local or area temperature influences from this energy would be insignificant.

The bulk of the proposed facility's electrical energy demands arise from two process requirements: (1) evaporate water from the raw waste to meet disposal site criteria and shipping requirements, and (2) evaporate the water used to mobilize the sludge from the Melton Valley Storage Tanks.

The low-temperature drying waste treatment facility would employ a treatment process that would use a minimal quantity of nonhazardous additives for the stabilization of the RCRA metals found in the waste. The stabilization process is accomplished at ambient temperatures and pressures; thus, only minimal energy is needed to handle, store, and control the required additives. No additional mixing is required for the additives beyond that already needed to maintain the tank waste solids in suspension for pumping and homogeneity. Minimal additives also imply minimal expended energy to elevate the process temperature to evaporate water from the waste. No energy-intensive chemical processes would be used in the facility. No other treatment process steps require intensive energy or resource consumption. Water not removed by treatment would be stabilized before disposal (e.g., cementation, absorption, etc.).

Other energy and resource needs related to the project are limited by the relatively short operating life of the low-temperature drying waste treatment facility. While operator hours of productivity/m^3 of waste are fairly standardized in the industry (especially for remote sorting and segregation of the solids that result in the majority of operational hours at the facility), limiting the hours of plant operation reduces management, monitoring, maintenance, and support resources and associated energy needs. The Low-Temperature Drying Alternative would optimally lower the life-cycle cost by balancing the cost of creating capital equipment needed to accommodate the resources with the combined operations and maintenance and D&D costs of operating, and then dismantling the facility with the same resources.

No groundwater would be used for the Low-Temperature Drying Alternative. Table 4-17 identifies the utilities immediately available at the facility site, via a short extension and connection service. Specific energy requirements for the treatment facility operations are provided in Table 4-18. Actual usage would be a fraction of the peak demand. Water usage over the life of this alternative is estimated

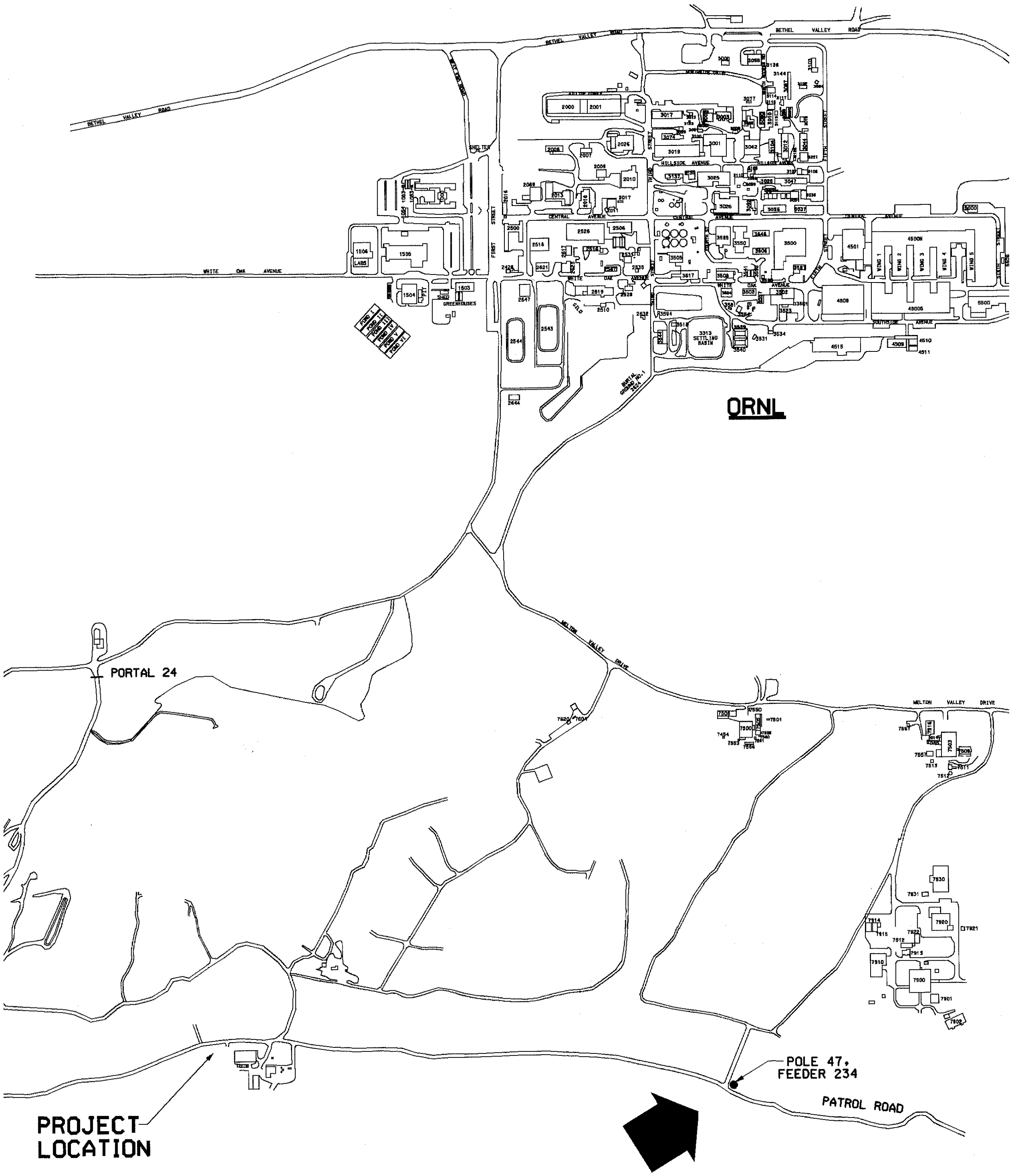

Figure 4-2. Location of additional power source.

Table 4-17. Utility requirements of the Low-Temperature Drying Alternative facility

Utility	Requirements	Usage
Potable water	Fire protection, drinking, sanitation, and process	900 gpm (peak)
Electricity	Heating, lighting, and operations	2,600 kW
Telephone	On- and off-site communications	25 voice lines 1 data line
Sewage	Sanitation	Collected and removed by commercial vendor
Solid waste	Housekeeping	Collected in bins and removed by commercial vendor

gpm = gallons per minute.
kW = kilowatt.

Table 4-18. Facility energy requirements (connected load) for the Low-Temperature Drying Alternative

Consumer	hp	Electrical (kW)
Drying/filtration mechanical equipment	100	75
Sludge/supernate retrieval equipment	20	15
CH solids handling equipment	67	50
RH solids handling equipment	40	30
Process off-gas treatment	54	40
Process chillers	228	170
Shipping/receiving	40	30
Steam boiler	—	1,172
Steam boiler pumps	10	8
Instrument/plant air compressor	100	75
Building HVAC fans	200	149
HVAC chillers	335	250
Total operating	1,195	2,063
Total design	× 1.25 = 1,493	× 1.25 = 2,579

CH = contact-handled.
hp = horsepower.
HVAC = heating, ventilation, and air conditioning.
kW = kilowatt.
RH = remote-handled.

at 5 million gal (Jones 1999). On a daily basis, this treatment method would use less than 10% of the 1,000 gal per minute (gpm) DOE has allotted for the proposed TRU Waste Treatment Facility. This is a minimal amount compared to the 1.2 million gal per day used at ORNL.

4.9.4 Vitrification Alternative

The Vitrification Alternative would require 45,000 MW of power. Similar to the Low-Temperature Drying Alternative, the conversion and dissipation of this electrical energy would be primarily to heat energy, both latent (in the form of evaporated water) and sensible (warmed air emitted from the building stack). The bulk of electrical energy demands for the Vitrification Alternative would be from vitrification of the tank waste to meet the Waste Isolation Pilot Plant waste acceptance criteria and shipping requirements. Another significant consumer of energy would be the HVAC systems.

The other utility demands, and the sources for these utilities, would be similar to those previously discussed for the Low-Temperature Drying Alternative. Water use is projected at 7 million gal over the life of the Vitrification Alternative.

4.9.5 Cementation Alternative

The Cementation Alternative would require 11,250 MW. The substantial portion (25 to 30%) of electrical energy demands for the Cementation Alternative is from the HVAC systems. Water usage would be approximately 15 million gal, which is still insignificant compared to the available water.

4.9.6 Treatment and Waste Storage at ORNL Alternative

Energy and water usage for this alternative depends primarily on the treatment alternative selected, which are discussed in the preceding sections. The utility requirements for waste storage are assumed to be similar to the requirements for the existing waste storage facilities (using 2,200 MW and 5 million gal of water over the institutional control period for waste storage).

4.9.7 Utility Impacts Summary

None of the alternatives, including the No Action Alternative, would require the use of any groundwater. The No Action Alternative would require a total of 2,200 MW of electricity, compared to 15,000 MW for the Low-Temperature Drying Alternative; 45,000 MW for the Vitrification Alternative; and 11,250 MW for the Cementation Alternative. Water use would continue at present levels under the No Action Alternative, totaling 5 million gal over the assumed 100 years of institutional control. The treatment alternatives would involve water use as part of waste treatment. The Low-Temperature Drying Alternative would require 5 million gal of water, the Vitrification Alternative would require 7 million gal, and the Cementation Alternative would require 15 million gal, compared to 5 million gal for the No Action Alternative. The Treatment and Waste Storage at ORNL Alternative would require an additional 5 million gal of water and 2,200 MW of electricity for interim storage of the treated wastes onsite (conservative approach assumes institutional control for 100 years).

4.10 HUMAN HEALTH IMPACTS

This section discusses the potential human health risks associated with routine operations of the proposed treatment facility for the four waste streams identified in the proposed action.

Since the proposed treatment facility would be located on 2 to 2.8 ha (5 to 7 acres) in the Melton Valley area of ORNL, the population of concern is found in four Tennessee counties including: Anderson, Roane, Knox, and Loudon, which serve as the reference area for human health impacts. The nearest resident is located approximately 3.2 to 4.8 km (2 to 3 miles) from the proposed facility. The nearest sensitive subpopulation, such as children, is located at the residences surrounding the ORR, and the nearest high-risk receptors (e.g., nursing homes, hospitals, schools, or day care centers) are found in the city of Oak Ridge (population of 27,310) located northeast of the ORR. The nearest large metropolitan area within 80 km (50 miles) of the facility is Knoxville, Tennessee, (population of 165,000). Approximately 880,000 people live within 80 km (50 miles) of the ORR (ORNL 1995a).

The dose limit established by DOE for members of the general public from all sources of radiation (except natural background and radiation received as a medical patient) is 100 mrem/year. DOE recommends that remedial actions be sufficient enough that the likely potential dose to the public is less than 30 mrem from one year of exposure. However, since the facility is located at the ORR on Federal property, institutional control would prevent exposure to private residents for many years.

4.10.1 Methodology

The methods used to determine the potential impacts to human health are discussed below.

- Performed risk assessment using CAP-88, Version 2.0, which provided an estimate of the adverse effects to the offsite affected (public) population and MEIs (involved worker, non-involved worker, and public). Fifty radionuclides from the predicted total emissions of all four waste streams were modeled. CAP-88 can model a maximum of 36 radionuclides in a single run, so two model runs were performed for each of the MEI and population assessments; the first run included 36 radionuclides, the second run included 14 radionuclides, and the totals were summed.

- Determined radionuclide concentrations in air, rates of deposition on ground surfaces, concentrations in food, and intake rates from ingestion.

- Modeled exposure pathways including inhalation, ingestion, and immersion in an airborne plume.

- Estimated the plume dispersion using meteorological data described in Section 3.7. The following parameters and assumptions used in the CAP-88 model for alternatives involving waste treatment are stated below.

    — stack height = 27.43 m (90 ft),
    — stack diameter = 1.52 m (5 ft),
    — plume rise = 12.7 m/s (42 ft/s),
    — mixing height = 1000 m (3,281 ft),
    — 5E-04 fatal cancers per rem were assumed for the general public, and
    — 4E-04 fatal cancers per rem were assumed for workers.

- Involved worker exposures from stack releases are 100 m or greater from the stack and probably are conservative for this release; involved workers are generally inside or near the treatment facility. Involved workers would have administrative controls in place for protection from emissions inside the facility.

- Computed the total exposure due to the combination of radionuclides and chemicals using the Industrial Source Complex Model Code, Version 3 (ISCST3), an EPA model that determines the dispersion of airborne pollutants. This model predicts atmospheric concentrations from a continuous point source based on a unit emission rate of 1 gram per second (g/s), and was used to estimate the exposures to the combined concentrations of radionuclides (pCi/m^3), particulates, and volatile organics (mg/m^3) at various locations near the proposed facility. ISCST3 uses the average hourly meteorological data records to define the conditions for plume rise, transport, diffusion, and deposition. Concentrations are estimated for each block in a circular grid comprising 16 directional sectors (e.g., north, northeast, north-northeast, etc.) at 10 radial distances within 80 km (50 miles) of the facility. The calculated concentration at each location was multiplied by the estimated emission of each contaminant (EPA 1995).

- Determined the dose to the public from residual radioactive contamination using the DOE model RESRAD, Version 5.82, in order to comply with DOE Order 5400.5. Residual radioactivity after site D&D was estimated from anticipated air emissions that would occur during operations at the proposed facility. The following assumptions were made when RESRAD was used in this evaluation.

  — Excluded radionuclides with a short half-life, and unlikely to present a risk following D&D of the proposed treatment facility.
  — Excluded radionuclides already present in the environment, if their activity due to emissions from the treatment facility was determined less than the uncertainty of the measurement.

- Estimated the dose to a family living on the proposed facility site immediately following D&D activities using RESRAD. The following assumptions were used in this analysis.

  — Drinking water was obtained from an on-site well.
  — Ingested vegetables were grown onsite.
  — Raised cattle onsite to obtain their milk and meat supply.
  — Default values were used as a conservative bound.

- Calculated the hazard index (non-carcinogenic contaminants), which is an indicator of the total additive, non-cancer toxicity from exposure to mixtures of hazardous contaminants. The hazard index is calculated by summing the hazard quotients for each noncarcinogen. A hazard index less than or equal to 1.0 indicates the exposure is unlikely to produce adverse toxic effects. As the hazard index approaches 1.0, concern about the potential hazard increases. The hazard index does not provide a statistical probability that a particular mixture at a particular exposure level will cause a particular adverse effect; it is an indicator of the relative potential for causing harm (ORNL 1995b,c).

- Calculated the LCF (carcinogenic contaminants). Cancer resulting from risks below 1E-06 cannot be distinguished from the normal cancer rate in an exposed population (EPA 1991).

4.10.2 Exposure pathways

The primary exposure pathways from the proposed treatment facility are ingestion and inhalation of contaminants from stack emissions. Stack emissions would occur during the 7,200 hours that the treatment facility is operational. For all treatment alternatives, air released from the stack would pass through a series of two HEPA filters, with a removal efficiency of more than 99%. It is anticipated that the total radioactive material that would be released is 5.48E-03 curies. The majority of the radioactive emissions will be strontium-90, cesium-137, and europium-152. The anticipated maximum release rate for volatile organic compounds is 0.062 lb/hour. The anticipated maximum release rate for particulate matter is 0.086 lb/hour. Secondary exposure pathways include immersion in the plume and external exposure due to ground surface contamination.

The facility operations for the treatment alternatives do not involve any water or wastewater discharges directly to the environment. Surface storm water runoff would enter Melton Branch or White Oak Creek, which are monitored under the ORR Environmental Monitoring Plan. Facility operations would not affect the groundwater, and no known drinking water supplies exist within 0.8 km (0.5 miles) of the facility. Therefore, contaminated surface water or groundwater was not considered as a potential exposure pathway when estimating radiation doses using the CAP-88 computer program. Waterborne pathways were considered when estimating the dose to a hypothetical family living on the land immediately after the facility D&D activities using the RESRAD computer program.

However, under the No Action Alternative, releases from the SWSA 5 North trenches pose a threat. After loss of institutional control, this threat increases due to the eventual release of radioactive contamination from the bunkers and buildings in the SWSA 5 North area and the Melton Valley Storage Tanks. See Section 4.5.1.2 regarding impacts to surface water after loss of institutional control.

4.10.3 No Action Alternative

The exposure to workers performing monitoring and maintenance activities during the 100-year institutional control period would result in 2E-02 LCFs for the population of involved workers. The LCF to the involved worker was calculated by assuming that 5 workers each receive the 100-mrem annual administrative control limit every year for 100 years multiplied by 4E-04 LCF/rem. While the workers are likely to work part-time at these facilities, it is assumed they receive all their administrative control limit dose here. There would be minimal risk to non-involved workers and the public during the institutional control period. See also Section 4.5.1.2.

After loss of institutional control, there would be continued releases from the SWSA 5 North trenches and contaminant releases from the buildings and bunkers at SWSA 5 North in addition to failure of the Melton Valley Storage Tanks. Assuming that all untreated wastes in these areas eventually release contaminants into the environment, human populations could be adversely affected. These releases would contaminate surface water and groundwater that could serve as drinking water sources and would likely affect potential food supplies as well. Human health impacts to the population would likely be significant over the long term. See also Section 4.5.1.2.

4.10.4 Low-Temperature Drying Alternative

4.10.4.1 Population of concern

The on-site population would vary depending on the project phase. There would be an estimated peak of 97 full-time equivalents during construction of the proposed facility, and a minimum of 17 full-time equivalents at the end of D&D activities. During operations, the number of full-time equivalents would range from 50 to 88, but only a fraction of these would be directly involved in the processing action.

4.10.4.2 Risk assessment

Radiation Exposure from Air - Maximally Exposed Individual

The maximally exposed involved worker would be located 100 m (328 ft) southwest of the stack, and the effective dose equivalent was calculated to be 6.4E-02 mrem. Based on the duration of stack emissions provided by Foster Wheeler for this alternative, the total exposure time would be 7,200 hours. The non-involved worker was assumed to be an average of 200 m (656 ft) southwest of the stack, which resulted in an effective dose equivalent of 5.5E-02 mrem. The nearest resident is approximately 3.2 to 4.8 km (2 to 3 miles) from the facility (ORNL 1995a). The off-site public MEI is located 1,250 m (4,101 ft) southwest of the facility, and the effective dose equivalent is 2.2E-02 mrem. The annual dose each person receives from natural background radiation is about 300 mrem, and the NESHAPs limit is 10 mrem/year. The total probability of cancer fatalities to the maximally exposed worker (involved and non-involved) and the off-site public MEI is 3E-08, 2E-08, and 1E-08, respectively.

Radiation Exposure - Affected Population

Risk analysis was performed for radiation exposure for the population within 80 km (50 miles) of the facility. The collective dose to the affected population would be 1.2E-01 person-rem. The total LCFs risk is 6E-5 fatalities per year. The doses and associated risks from radionuclide exposure are summarized in Table 4-19.

Table 4-19. Dose and risk due to radionuclide emissions from the Low-Temperature Drying Alternative

Receptor	Effective dose equivalent	Cancer fatalities
Maximally exposed individual (involved worker)	6.4E-02 mrem	3E-08 (probability)
Maximally exposed individual (non-involved worker)	5.5E-02 mrem	2E-08 (probability)
Maximally exposed individual (off-site)	2.2E-02 mrem	1E-08 (probability)
Population	1.2E-01 person-rem	6E-05 (deaths/year)

Radiation Exposure - Facility Worker

In order to protect workers, the facility walls would be designed to maintain exposures per ALARA objectives. The two primary gamma emitters present in the waste are cobalt-60 (half-life of 5.27 years) and cesium-137 (half-life of 30.17 years). The wall thickness or shielding material would reduce the dose rate to 0.5 mrem/h in normally occupied radiological areas and to 0.25 mrem/h in normally occupied non-radiological areas. It is stated in 10 *CFR* 835 that radiological operations shall be controlled so that the annual total effective dose equivalent (TEDE) limit of 5 rem to radiological workers is not exceeded. The TEDE for any member of the public shall not exceed 100 mrem in a year. The ORR imposes an administrative control that limits doses to 20% of the DOE-allowable dose limit. Assuming a facility worker receives the maximum administrative control limit dose of 100 mrem in a year, the associated 70-year risk using an incidence rate of 4E-04 fatal cancers per rem is a 3E-03 probability of fatal cancer.

Total Exposure Due to Radionuclides and Chemicals from Air

The ISCST3 model, as described in Section 4.10.1, was used to analyze the combined concentrations of radionuclides, particulate matter, and organic emissions. Estimated concentrations are determined for each block in a circular grid comprising 16 directional sectors (e.g., north, northeast, north-northeast, etc.) at 10 radial distances within 80 km (50 miles) of the proposed facility. The calculated concentration at each location was multiplied by the estimated emission of each contaminant (EPA 1995). The total exposure time was assumed to be equivalent to the operational time of the facility, or 7,200 hours. Like CAP-88, ISCST3 also uses the Gaussian plume equation to determine the dispersion of pollutants and includes the same assumptions and limitations discussed in Section 3.10.2. Table 4-20 summarizes the endpoints (health effects) that were estimated for the anticipated airborne emissions from the facility.

Table 4-20. Summary of health effect endpoints

Type of contaminant	Endpoint
Noncarcinogen	Hazard index[a]
Chemical carcinogen	Cancer incidence[a]
Radionuclide	Cancer fatality[b]

[a]Estimated with ISCST3.
[b]Estimated with CAP-88.

The results from the ISCST3 modeling were used to determine the hazard index at various locations near the facility. In all cases, the hazard index was zero. The data and parameters used in the ISCST3 code are provided in Appendix E of "Required Information for the National Environmental Policy Act for the Treating of Transuranic/Alpha Low-Level Waste at ORNL" (Foster Wheeler 1999).

The lifetime risk of cancer was estimated, and the highest-risk occupied area was 1,500 m (4,921 ft) northeast of the facility with a cancer risk of 4E-11. Cancer incidence resulting from risks below 1E-06 cannot be distinguished from the normal cancer rate in an exposed population and is considered acceptable by EPA (EPA 1991).

Residual Contamination After D&D

The pathways modeled by RESRAD, Version 5.82 were inhalation, ingestion of milk, ingestion of meat, vegetation, aquatic animals, drinking water, and inadvertent soil ingestion. The highest total dose from all exposure pathways was estimated to be 2.28 mrem, approximately 5 years after D&D of the facility. The data and parameters used in the RESRAD code are provided in Appendix F of "Required Information for the National Environmental Policy Act for the Treating of Transuranic/Alpha Low-Level Waste at ORNL" (Foster Wheeler 1999).

4.10.5 Vitrification Alternative

Emissions of concern for the Vitrification Alternative include radionuclides, particulates, and volatile organics. Mitigation of potential emissions is discussed in Section 4.7.4. It is anticipated that the use of off-gas treatment systems would result in compliance with applicable air standards. CAP-88 was used to estimate the dose and risk from radionuclide emissions from the proposed facility using the same assumptions and parameters discussed in Section 4.10.1. The maximally exposed involved worker was assumed to be located 300 m (984 ft) southwest of the stack. The dose and risk to the MEIs and the surrounding population are shown in Table 4-21.

The average annual particulate and metal emissions using the Vitrification Alternative are significantly less than those from the Low-Temperature Drying Alternative. The impacts from non-radiological emissions would be negligible. The dose due to residual contamination after D&D is anticipated to be approximately equivalent to that for the Low-Temperature Drying Alternative since the total anticipated radionuclide emissions are approximately the same.

Table 4-21. Dose and risk due to radionuclide emissions from the Vitrification Alternative

Receptor	Effective dose equivalent	Cancer fatalities
Maximally exposed individual (involved worker)	2.2E-01 mrem	9E-08 (probability)
Maximally exposed individual (non-involved worker)	1.8E-01 mrem	7E-08 (probability)
Maximally exposed individual (offsite)	9.8E-02 mrem	5E-08 (probability)
Population	6.8E-01 person-rem	3E-09 (deaths/year)

4.10.6 Cementation Alternative

Emissions of concern for the Cementation Alternative include radionuclides, particulates, and volatile organics. Contaminant emissions and human health impacts would be expected to be similar to than the Low-Temperature Drying Alternative. CAP-88 was used to estimate the dose and risk from radionuclide emissions from the proposed facility using the same assumptions and parameters discussed in Section 4.10.1. The maximally exposed involved worker was assumed to be located 100 m (328 ft) southwest of the stack. The dose and risk to the MEIs and the surrounding population are shown in Table 4-22.

Table 4-22. Dose and risk due to radionuclide emissions from the Cementation Alternative

Receptor	Effective dose equivalent	Cancer fatalities
Maximally exposed individual (involved worker)	1.6E-02 mrem	6E-09 (probability)
Maximally exposed individual (non-involved worker)	1.3E-02 mrem	5E-09 (probability)
Maximally exposed individual (offsite)	5.1E-03 mrem	3E-09 (probability)
Population	2.8E-02 person-rem	1E-05 (deaths/year)

The average annual particulate and metal emissions using the Cementation Alternative are significantly less than those from the Low-Temperature Drying Alternative. The impacts from non-radiological emissions would be negligible. The dose due to residual contamination after D&D is anticipated to be approximately equivalent to that for the Low-Temperature Drying Alternative since the total anticipated radionuclide emissions are approximately the same.

4.10.7 Treatment and Waste Storage at ORNL Alternative

The impact to public health from this alternative would be dependent on the treatment alternative selected and would be equivalent to the impact for that alternative, as previously summarized in Tables 4-19, 4-21, and 4-22. Storage of the waste onsite at ORNL following treatment would not result in additional risk to the public or to non-involved workers during institutional control. There would be an additional risk to the involved worker population due to radiological exposure, since the stored waste would be inspected and routine surveillance and maintenance performed. Involved workers are currently performing maintenance and surveillance tasks and are currently in compliance with the annual administrative control dose limit of 100 mrem/person/year. Similarly, it is anticipated that the administrative control limit will be met over the 100-year institutional control period for waste storage. Assuming the total number of involved workers over the 100-year period averages 5 per year, and the 100 mrem annual administrative control limit is maintained, the total dose to the involved worker population would be 50 person-rem, and the associated LCF would be 2E-02.

After loss of institutional control, waste constituents would eventually be released into the environment. Human health impacts are likely but risks are expected to be less than those associated with the No Action Alternative because wastes are treated and better contained.

4.10.8 Human Health Impacts Summary

There would be minimal risks to non-involved workers and the public for the No Action Alternative during the 100-year institutional control period. Involved workers would continue to receive the exposure they currently receive during surveillance and maintenance activities. Over the 100-year institutional control period for on-site waste storage, this would result in 2E-02 LCFs. However, after loss of institutional control, waste constituents from the Melton Valley Storage Tanks and the SWSA 5 North trenches, bunkers, and buildings would be released into the environment with potential adverse health consequences. Table 4-23 summarizes the probability of cancer fatalities for the treatment alternatives.

Table 4-23. Total probability of cancer fatality summary table for the treatment alternatives during institutional control[a]

Alternative	On-site maximally exposed worker	Non-involved maximally exposed worker	Off-site MEI (public)
No Action	NA	Negligible	Negligible
Low-Temperature Drying	3E-08	2E-08	1E-08
Vitrification	9E-08	7E-08	5E-08
Cementation	6E-09	5E-09	3E-09

[a]For the Treatment and Waste Storage at ORNL Alternative, risks would be dependent on the treatment method selected, although there would be no additional risk to non-involved workers or the public. Involved workers for both the No Action and Treatment and Waste Storage at ORNL Alternatives would have 2E-02 LCFs due to 100-year surveillance and maintenance activities.

MEI = maximally exposed individual.
NA = not applicable.

The collective dose to the population from the Low-Temperature Drying Alternative would be 0.12 person-rem and 6E-05 deaths/year. The collective dose to the population for the Vitrification Alternative would be 6.8E-01 person-rem and would result in 3E-04 deaths/year. The collective dose to the population from the Cementation Alternative would be 2.8E-02 person-rem and 1E-05 deaths/year. For the Treatment and Waste Storage at ORNL Alternative, there would be some additional exposure due to the storage of the treated wastes onsite at ORNL.

4.11 ACCIDENT IMPACTS

This section addresses potential accident scenarios caused by equipment failures, human errors, or natural phenomena, which could result in the release of radiation, radioactive or hazardous materials, and have adverse effects on environment and the health of workers and the public. Accident scenarios were evaluated for each of the alternatives. The types of accident scenarios evaluated include:

- A breach of the Melton Valley Storage Tanks resulting in waste released to the environment.
- A breach of the transfer line between the Melton Valley Storage Tanks and the proposed TRU Waste Treatment Facility resulting in waste releases to the environment.
- Failure of a waste slurry line inside the proposed TRU Waste Treatment Facility.
- Failure of a waste slurry line and HEPA filters inside the proposed TRU Waste Treatment Facility.
- Failure of contact-handled or remote-handled solid waste containers before, during, and after waste treatment.
- Accidents unique to each alternative.
- Industrial accidents occurring during operations of the TRU Waste Treatment Facility or storage.

The scenarios analyzed represent the range of potential hazards associated with each alternative. Seismic risk to the Melton Valley Storage Tanks is more important for the No Action Alternative than the other alternatives, due to the long-term storage (100 years institutional control) of the untreated waste in the tanks. The analysis assumes that all of the accidents would occur within the proposed TRU Waste Treatment Facility, with the exception of a breach of the Melton Valley Storage Tanks, a breach of the transfer line between the Melton Valley Storage Tanks and the proposed TRU Waste Treatment Facility, or waste containers stored before and after treatment.

4.11.1 Methodology

The estimated accident consequences were based on the inventories and material characteristics of the waste contained in the Melton Valley Storage Tanks and the solid TRU wastes stored on the ORNL site. Atmospheric and surface water transport characteristics were obtained from the *Safety Analysis Report for the Liquid Low-Level Waste Management Systems* (Bechtel Jacobs 1999). Methods used to evaluate the significance of the potential adverse effects from the described accidents are listed below.

- Estimated the frequencies of potential accidents occurring for each alternative.
  - "anticipated" accidents have a frequency of greater than 1 in 100 per year (>1E-02 per year);
  - "unlikely" accidents have a frequency ranging between 1 in 100 to 1 in 10,000 per year (1E-02 to 1E-04 per year); and
  - "extremely unlikely" accidents have a frequency ranging between 1 in 10,000 to 1 in 1,000,000 per year (1E-04 to 1E-06 per year). These accidents were not considered credible as evaluation basis events, and were not evaluated.

- Quantified the estimated amount of any release to the environment (air or surface water) resulting from an accident.

- Quantified the radiological dose to an MEI at the ORR boundary, and the radiological does to the surrounding public populations due to the releases. There is no public MEI for the ingestion pathway.

- Evaluated the radiological effects of accidents on workers:

  — Quantified the ingestion doses to the MEI and worker population at ETTP (the only workers assumed to ingest the contaminated water released in an accident are those at ETTP with a downstream potable water intake).

  — Quantified the inhalation doses to maximally exposed, non-involved workers at 80 m (or more) from the release point. For elevated releases from the 27-m-high stack, the maximum ground level concentration and dose occur at the site boundary and are equal to those for the public MEI at the ORR boundary.

- Qualitatively evaluated the accident effects on involved facility workers:

  — Building design physically separates workers from the drying process area.

  — Leaks/fires in process areas are expected to be exhausted directly (via filters) and to not affect unprotected workers in other treatment building areas.

  — Administrative controls would be in place to protect workers.

  — Workers in process areas are expected to have appropriate breathing and other protective clothing and equipment. These workers are expected to evacuate the vicinity of an accident without significant consequence.

  — Workers outside the treatment building are considered non-involved unless they are performing specific tasks with appropriate protective equipment.

Based on these assumptions, the risk to involved workers is maintained acceptably low by the use of appropriate protective equipment and risk is not analyzed or discussed further.

- Determined the health consequences associated with the doses in terms of "Latent Cancer Fatalities" (LCF) for populations and probability of cancer fatalities for individuals that would result from the exposures and doses. Cancer fatality consequences to the affected populations were based on the fatal cancer incidence rates of 4E-04 LCF per person-rem in the worker populations and 5E-04 LCF per person-rem in the off-site public population as described in Chapter 3, Affected Environment. These risk factors also were applied to MEI and maximally exposed non-involved worker doses. The product of the dose and the fatal cancer incident rate is an estimate of the probability the exposed individual will experience a cancer fatality.

- Risk was measured as the average consequence that accounts for both the consequence and likelihood of an accident. For example, an accident with a low likelihood and high consequence can have the same risk as an accident with a high likelihood and low consequence. For the comparison of accidents affecting the No Action and treatment alternatives, the risk measure selected is total expected fatalities. This risk is computed as the product of the accident frequency, the time period in which the accident can occur, and the computed consequence. The risk is used to compare the expectation of fatalities for the no action and treatment alternatives on a consistent basis.

$$Risk = Total\ Expected\ Fatalities = \frac{Accidents}{Year} \times \frac{Years}{Alternative} \times \frac{Cancer\ \ fatalities}{Accident}$$

- The likelihood of industrial injuries, fatalities, and risks was estimated based upon the labor estimates discussed in Section 4.13, Socioeconomic Impacts.

The evaluation of each of the accidents scenarios follow. The consequences and likelihoods of process and storage accidents are based on those defined for the Melton Valley Storage Tanks in the *Safety Analysis Report for the Liquid Low-Level Waste Management Systems* (Bechtel Jacobs 1999). An accident scenario and associated assumptions are presented first, followed by the impacts for each alternative. A summary is provided at the end of each accident scenario to provide an easy comparison of the alternatives.

4.11.2 Accidental Breach of the Melton Valley Storage Tanks

An accidental breach of the Melton Valley Storage Tanks could result in the release of TRU sludge and its associated low-level liquid waste into the secondary containment of the Melton Valley Storage Tanks facility and potentially into the environment. The impacts associated with the alternatives were based on the assumption that the Melton Valley Storage Tanks and their secondary containment could withstand the evaluation basis earthquake (0.2g ground acceleration) (Bechtel Jacobs 1999) that occurs with a frequency of 1E-03 per year over a 10- to 20-year period. For facility operating periods of approximately 20 years or less, it is reasonable to assume that only evaluation basis-type accidents and natural phenomena and limited accident consequences would occur.

4.11.2.1 No Action Alternative

For the analysis of the No Action Alternative, it was assumed that the radioactive liquid wastes would be stored in the Melton Valley Storage Tanks without treatment for the 100 years of institutional control, and that a more severe, “Beyond Evaluation Basis” accident would occur. The No Action Alternative is assumed to begin after current Melton Valley Storage Tanks waste consolidation operations are terminated. Within this storage period, an earthquake with approximately double the intensity of the evaluation basis earthquake could occur with equal likelihood (i.e., 10 years × 1E-03 per year = 100 years × 1E-04 per year = 0.01). If a “Beyond Evaluation Basis” earthquake were to occur, there is a potential for the Melton Valley Storage Tanks and their secondary containment to fail causing the liquid wastes to be discharged via White Oak Creek to the Clinch River. The affected populations would include the workers at ETTP and the off-site population in Kingston, Tennessee, that use the Clinch River as a drinking water source.

A “Beyond Evaluation Basis Accident” resulting in liquid waste release from the Melton Valley Storage Tanks and a limited failure of the secondary containment was addressed in the *Safety Analysis Report for the Liquid Low-Level Waste Management Systems* (Bechtel Jacobs 1999). In this accident, the total volume of liquid released to the environment was assumed to be limited to 50,000 gal, and it was also assumed that the use of this water as a drinking water supply was not banned. The resulting consequence was estimated to range between 4 and 28 rem to a MEI at ETTP (assumed to drink 1 liter of this water), depending on the dilution flow rate in the Clinch River. For purposes of this analysis, the midpoint of 16 rem was assumed as the dose from ingestion at ETTP.

The human health consequences of an accidental release due to an earthquake were based on the airborne and waterborne pathways, doses, and a fatal cancer incidence rate (4E-04 LCF/person-rem for workers and 5E-04 LCF/person-rem for the public). The 16 rem accidental dose to the MEI at ETTP due to a release from the Melton Valley Storage Tanks is a factor of 107,000 times higher than would occur due to expected releases from ORNL (0.15 mrem) (ORNL et al. 1997). By proportion, the corresponding affected population doses (assuming a limited ingestion of 1 L/person of contaminated water) are 31,000 person-rem (0.29 person-rem due to normal releases) to the ETTP population and 160,000 person-rem (1.5 person-rem due to normal releases) to the Kingston population (ORNL et al. 1997). The projected consequences are 12 LCFs in the ETTP worker population and 80 LCF in the Kingston population due to ingestion of contaminated drinking water (Table 4-24).

Airborne releases from ORNL occurring in 1997 resulted in a 0.38 mrem dose to the off-site MEI and a collective dose of 5.8 person-rem to the surrounding population of 879,546 within 80 km (50 miles). The corresponding affected population doses due to an accidental release from the Melton Valley Storage Tanks due to an earthquake under the No Action Alternative were obtained by proportion. The ratio of the "Beyond Evaluation Basis" earthquake site boundary MEI inhalation dose of 2.12 rem to the 1997 ORNL MEI site boundary dose is 5,600. Comparably, the affected population inhalation dose for the earthquake scenario is 5,600 times the 5.8 person-rem 1997 population dose, or 32,000 person-rem. The inhalation dose consequence to the surrounding population due to the earthquake is 16 LCF in addition to the ingestion consequence. The corresponding consequence to the 2.1 rem MEI dose is a 1.1E-03 probability of a cancer fatality.

Table 4-24. Frequencies and consequences of the No Action Alternative for Melton Valley Storage Tanks storage accidents

Accident	Accident frequency	MEI accident boundary doses[a] (rem)	Affected population dose per accident (person-rem)	Total LCF per accident
Beyond Evaluation Basis Earthquake	1E-04 per year	Ingestion - 16	Ingestion -	
			(ETTP) 31,000	12
			(Kingston) 160,000	80
		Inhalation - 2.1	Inhalation - 32,000	16
			Total	108

[a]Accident frequencies and maximally exposed individual (MEI) boundary doses based on Bechtel Jacobs 1999. Inhalation boundary doses are at the Oak Ridge Reservation boundary (public MEI), and the ingestion boundary doses are at East Tennessee Technology Park (non-involved worker).

LCF = latent cancer fatality.

The inhalation dose to a non-involved worker 80 m from the ground-level release point is computed based on the 2.1 rem ORR MEI boundary dose (Bechtel Jacobs 1999), and the ratio of the χ/Q values at 80 m and the ORR boundary (1,439 m). For F-stability conditions and a wind speed of 1 m/s, the ratio of the χ/Q values is 108 (Turner 1969). The resulting dose to the non-involved worker is 230 rem. The corresponding consequence is a 0.092 probability of a cancer fatality.

The associated risk computed for the "Beyond Evaluation Basis" earthquake accident is 1.1 expected fatalities based on the 108 LCF, the 1E-04/year frequency, and the 100-year institutional period of control. The risks to the MEI and non-involved worker are 1.1E-05 and 9.2E-04 expected fatalities, respectively.

A breach of the Melton Valley Storage Tanks from an earthquake resulting in a 50,000 gal release of radioactive waste would contaminate approximately 0.56 ha (1.37 acres) of land and 24,526 m^3 (32,083 yd^3) of soil. Complete calculations and assumptions are presented in Appendix F.3. Until an environmental cleanup could occur, and the waste and impacted soil be removed, the land use would be significantly altered from its present condition and would be unusable for other purposes. Aquatic biota in a 1-kilometer (0.6-mile) reach of Melton Branch and White Oak Creek would be killed by chemical toxicity, perhaps by high pH, and possibly by acute external radiation exposure (Appendix F.2). Recolonization of this reach would take up to a year. Herons and other fish-eating biota could be harmed by acute external radiation exposure if they remain in close proximity to the released water. The contaminants would likely move quickly downstream to White Oak Creek, where radiation toxicity is also probable. Dilution of the non-radioactive contaminants in White Oak Lake would rapidly (in a few days) reduce the concentrations of contaminants below levels causing chemical toxicity, and the pH would probably change to non-toxic levels. However, chronic radiation doses to aquatic biota and fish-eating predators in White Oak Lake would remain above benchmarks for acceptable chronic radiation levels for a few days to a few weeks. The predominant exposures are to cesium-137 from Melton Valley Storage Tank W-26, or to cesium-137, cobalt-60, and strontium-90 from Melton Valley Storage Tank W-28. Dilution of contaminants by their release into the Clinch River would reduce radiation doses to aquatic biota and fish-eating predators to acceptable levels.

In this accident scenario for the No Action Alternative, with 189,250 L (50,000 gal) of liquid waste released to the environment, there is a potential impact to the soil and groundwater. (Appendix F.3 details the evaluation of the impacts of such a release). For evaluation purposes, it was assumed that liquid waste would leak from the secondary containment in a band as wide as 45.72 m (150 ft) across the lower front edge of the vault, in a zone parallel to slope down to the Melton Branch. Furthermore, it is assumed that the waste would initially leak through the unsaturated overburden impacting a volume of soil 45.72 × 22.86 × 3.96 m (150 × 75 × 13 ft) prior to reaching the groundwater surface. Once the waste reaches the water table/groundwater surface, it is further assumed that waste would mix with the shallow groundwater and ultimately discharge out to Melton Branch approximately 121.92 m (400 ft) away. Details of this conceptual model are depicted in Appendix F.3, Figure 1. Such a release could potentially impact 0.557 ha (1.3 acres) of area and 24,526 m^3 (866,160 ft^3) of soil.

The impacts to the groundwater from a breach of the Melton Valley Storage Tanks under the No Action Alternative included the assumption that Melton Valley Storage Tank W-28 would breach and spill its entire contents (approximately 189,250 L or 50,000 gal). The strontium-90 concentrations in this tank were reported to be 1.5 E+05 Becquerels/mL (Keeler 1996). This concentration in tank W-28 indicates that strontium-90 accounts for approximately 15% of the total radioactive material in that tank (as measured in Becquerels). Assuming that the concentrations reported are accurate for all the waste in tank W-28, approximately 766 curies of strontium-90 would be released to the environment from this accident scenario. If the mass of strontium-90 were evenly distributed across the potentially impacted area described above, the concentrations in the soil and groundwater would equate to 2.08E+07 pCi/kg and 1.04E+06 pCi/L, respectively. Based on assumed soil/water partitioning interactions, the maximum values that could be expected would be equal to 8.09E+10 pCi/kg in the soil and 4.05E+09 pCi/L in the groundwater. All calculations are detailed in Appendix F.3.

These resulting concentrations in the soil and groundwater would be significant if this accident scenario were to occur, since little to any previous impact for strontium-90 has been reported for the soil and groundwater near the proposed TRU Waste Treatment Facility and south of the Melton Branch. Furthermore, these concentrations reflect an apparent driver for remediation when compared to the 10^{-6} residential risk scenario values of 0.014 pCi/kg and 0.85 pCi/L for soil and water (RAIS, 1/11/2000). If remediation (soil removal and replacement) is assumed, then over 24,526 m^3 of contaminated soil would have to be removed and stored onsite. This would require approximately 2.4 ha (6 acres) of storage space based on the storage volumes presented in Table 2-4 for similar waste. In addition, the 100-year and 500-year floodplains and wetlands between the Old Melton Valley Road and Melton Branch would be adversely impacted by both the contaminant plume (Figure 1, Appendix F.3) and the earthmoving associated with remediation.

Following the 100-year institutional control period addressed above, loss of institutional control is assumed for analysis purposes. If an accident has not occurred by this time, the wastes are assumed to continue to remain in place. As a bounding accident health impact for the No Action Alternative, the hypothetical consequences and risks of releasing the contents of all Melton Valley Storage Tanks (1,514,000 L or 400,000 gal) over an indefinitely long period of time (e.g., 10,000 years) are computed.

After 100 years, most of the activity in the Melton Valley Storage Tanks (95% of the strontium-90 and cesium-137) will have decayed. However, the total activity in the larger waste volume released increases by a factor of 4.26 over the total activity in the previously assumed release of the highest activity, 189,250 L or 50,000 gal (based on current radionuclide distributions). Thus, over the 100- to 200-year period, the consequence of a large release, earthquake accident would decrease by a factor of approximately 4 to 26 LCF, and the risk over this period would decrease to 0.26 expected fatalities (combined ETTP and Kingston populations).

Over an indefinite time period, all of the waste in the tanks will be released (with a probability of 1.0 assuming no maintenance of the steel tanks and reinforced concrete containment). If the population distribution and surface water transport paths remain the same, the consequence of this release is an estimated 11 LCF, and the risk is 11 expected fatalities over the very large time period.

4.11.2.2 Low-Temperature Drying Alternative

Since the Low-Temperature Drying Alternative would be completed in less than 10 years, the probability of a “Beyond Evaluation Basis” earthquake occurring is small, and therefore was not evaluated.

4.11.2.3 Vitrification Alternative

Since the Vitrification Alternative would be completed in less than 10 years, the probability of a “Beyond Evaluation Basis” earthquake occurring is small, and therefore was not evaluated.

4.11.2.4 Cementation Alternative

Since the Cementation Alternative would be completed in less than 10 years, the probability of a “Beyond Evaluation Basis” earthquake occurring is small, and therefore was not evaluated.

4.11.2.5 Treatment and Waste Storage at ORNL Alternative

Since waste treatment under this alternative would be completed in less than 10 years, the probability of a “ Beyond Evaluation Basis” earthquake occurring is small, and therefore was not evaluated.

4.11.3 Breach of the Transfer Line Between the Melton Valley Storage Tanks and the Proposed TRU Waste Treatment Facility

The frequency and consequences of a transfer line failure between the Melton Valley Storage Tanks and the proposed TRU Waste Treatment Facility are the same for all of the alternatives that include waste treatment. This type of accident has been evaluated in the *Safety Analysis Report for the Liquid Low-Level Waste Management Systems* (Bechtel Jacobs 1999); two accidents were evaluated:

Accident	MEI Inhalation dose	Ingestion dose[a]
Component failure during sludge transfer	2.1 rem	0
Tank overfill during sludge transfer	Approximately 0	6.1 rem

[a]Inhalation boundary doses are at the ORR boundary (public MEI) and the ingestion boundary doses are at East Tennessee Technology Park (non-involved workers).
MEI = maximally exposed individual

Due to Melton Valley Storage Tanks operational and design considerations, these two accidents do not result from a single cause. However, during waste transfer operations, both accidents could result from a complete line failure and direct release to the air and surface waters.

4.11.3.1 No Action Alternative

Since construction of a waste treatment facility would not be implemented for this alternative, this accident scenario was not analyzed.

4.11.3.2 Low-Temperature Drying Alternative

A breach of the transfer line between the Melton Valley Storage Tanks and the proposed waste treatment facility was estimated to occur in the "extremely unlikely" frequency range, 1E-04 to 1E-06 per year (Bechtel Jacobs 1999). Since sludge transfers to the proposed treatment facility are expected to be semi-continuous, the estimated frequency category is increased to the "unlikely" frequency range (1E-02 to 1E-04 per year).

To present a bounding analysis, the maximally exposed non-involved worker at ETTP is assumed to ingest surface waters and receive the bounding 6.1-rem dose. Based on the 6.1-rem boundary dose, the affected ETTP population ingestion dose is 12,000 person-rem and the corresponding consequence is 4.7 LCF. The public population at Kingston receives a dose of 61,000 person-rem with a consequence of 31 LCF.

The public MEI at the ORR boundary would be exposed to the airborne release and receive the bounding 2.1 rem dose. The inhalation dose to the public population within 50 miles, based on the ORR MEI boundary dose, is 32,000 person-rem. The corresponding consequence to this population is 16 LCF. The consequence of the 2.1 rem MEI dose is 1.1E-03 probability of a cancer fatality.

The ORR MEI (public) boundary inhalation dose for the transfer line failure is the same as that for the tank rupture accident, 2.1 rem. Therefore, the inhalation dose and consequence to the non-involved worker is also the same, 230 rem and 0.092 probability of a cancer fatality.

The estimated frequency for this accident is in the range of 1E-02 to 1E-04 per year for this accident; the midpoint frequency of 1E-03 per year was used to calculate the risk. The risk estimate is based on a total of 35 LCF due to ingestion in the ETTP and Kingston populations, and 16 LCF due to inhalation in the surrounding population within 50 miles. The total calculated risk is 0.16 expected fatalities. The risks to the public MEI and non-involved worker are 3.2E-06 and 2.8E-04 expected fatalities.

4.11.3.3 Vitrification Alternative

The frequency, consequences, and risks of a transfer line failure between the Melton Valley Storage Tanks and the proposed waste treatment facility are the same as those determined for the Low-Temperature Drying Alternative.

4.11.3.4 Cementation Alternative

The frequency and consequences of a transfer line failure between the Melton Valley Storage Tanks and the proposed waste treatment facility are the same as those determined for the Low-Temperature Drying Alternative. However, due to the increased period of the tank waste treatment under this alternative (6 years), the calculated risk is 0.31 expected fatalities in all affected populations. The risks to the public MEI and non-involved worker are 6.3E-06 and 5.5E-04 expected fatalities, respectively.

4.11.3.5 Treatment and Waste Storage at ORNL Alternative

The frequency and consequences of a transfer line failure between the Melton Valley Storage Tanks and the proposed waste treatment facility are the same as those determined for the Low-Temperature Drying Alternative. However, due to the variation of the tank processing period from 3 to 6 years, depending on the treatment method, the risk ranges from a total of 0.16 to 0.31 expected fatalities in all affected populations.

4.11.4 A Slurry Line Failure Within the TRU Waste Treatment Facility

The slurry line failure within the proposed TRU Waste Treatment Facility is similar to the transfer line failure between the Melton Valley Storage Tanks and the treatment facility, except this accident scenario assumes that major leaks would be confined within the proposed treatment facility and would be detected more rapidly (1 hour vs. 2 hours). This accident could potentially occur during any of the treatment alternatives. The HEPA filters are assumed to be degraded but still provide a factor of 100 reduction.

4.11.4.1 No Action Alternative

Since construction of a waste treatment facility would not be implemented for this alternative, this accident scenario was not analyzed.

4.11.4.2 Low-Temperature Drying Alternative

The slurry line failure accident within the proposed treatment facility is estimated to occur in the per year "unlikely" frequency range (1E-02 to 1E-04 per year).

Since the proposed facility would be designed as a "zero-release" facility, no direct release to surface waters would be possible. Any airborne releases would occur via HEPA filters and the 27-m (89-ft)-high stack. The shorter exposure reduces the dose by a factor of 2 and the elevated (versus ground level) release reduces the dose by a factor of 3 (χ/Q = 1.2E-04 s/m^3 vs. 3.7E-04 s/m^3) (Turner 1969). The resulting ORR boundary dose becomes 3.4E-03 rem.

$$\text{Dose} = 2.1\ \text{rem} \times \frac{1\ \text{h}}{2\ \text{h}} \times 0.01 \times \frac{1.2\text{E}-04}{3.7\text{E}-04} = 0.0034\ \text{rem}$$

Since the suspended radionuclides are released for the stack at an elevation of 27 m, the maximum ground-level dose occurs at the ORR boundary. Therefore, the maximum non-involved worker dose is equal to the public MEI dose at the ORR boundary. The corresponding consequences are 1.7E-06 and 1.4E-06 probabilities of a cancer fatality for the public MEI and non-involved worker, respectively.

The corresponding affected population inhalation dose resulting from this release is 52 person-rem to the surrounding population within 50 miles and a resulting consequence of 0.026 LCF. The corresponding risk, based on a 3-year risk period (corresponds to the tank waste treatment period), is 7.8E-05 expected fatalities. The risks to the MEI and non-involved worker are negligible.

4.11.4.3 Vitrification Alternative

The slurry line failure inside the proposed treatment facility would result in the same impacts as those calculated for the Low-Temperature Drying Alternative.

4.11.4.4 Cementation Alternative

The slurry line failure inside the proposed treatment facility would result in the same dose and consequence to the surrounding population within 50 miles as those calculated for the Low-Temperature Drying Alternative. The risk increases to 1.6E-04 expected fatalities due to the longer tank waste treatment period of six years. The risks to the public MEI and non-involved worker are negligible.

4.11.4.5 Treatment and Waste Storage at ORNL Alternative

The slurry line failure inside the proposed treatment facility would result in the same dose and consequence to the surrounding population within 50 miles as those calculated for the Low-Temperature Drying Alternative. The risk ranges from 7.8E-05 to 1.6E-04 expected fatalities depending on the tank waste treatment period for the selected treatment process. The risks to the MEI and non-involved worker are negligible.

4.11.5 Failure of the Slurry Line and the HEPA Filters in the Proposed TRU Waste Treatment Facility

This slurry line failure within the proposed TRU Waste Treatment Facility is similar to the slurry line failure discussed above, except this accident scenario assumes that the filters are in a failed state. It is assumed that the HEPA filters are damaged, or removed and not replaced, and a slurry line accident occurred in the building. The suspended hazardous particles in the air are assumed exhausted without filtration. This accident could potentially occur during any of the treatment alternatives.

4.11.5.1 No Action Alternative

Since construction of a waste treatment facility would not be implemented for this alternative, this accident scenario was not analyzed.

4.11.5.2 Low-Temperature Drying Alternative

Since the filter failure and the line failure are not coupled events, the estimated frequency of the combined events is estimated to be in the per year “extremely unlikely” (1E-04 to 1E-06) frequency range. A dose of 0.34 rem to a MEI at the ORR boundary would result if this accident occurred while the HEPA filters were in a failed state since the HEPA filters would not be able to provide the reduction factor of 100 assumed in the slurry line failure accident. Based on this ORR boundary dose, an inhalation dose of 5200 person-rem in the surrounding population within 50 miles in estimated. The corresponding consequence and risk in this population are 2.6 LCF and 7.8E-05 expected fatalities.

As with the slurry line failure with filtration, the maximum dose to the MEI and non-involved worker occurs at the ORR boundary and is equal to 0.34 rem. The corresponding consequences are 1.7E-04 and 1.4E-04 probabilities of a cancer fatality. The risks are the same as for the slurry line failure risks and are negligible for the public MEI and non-involved worker.

4.11.5.3 Vitrification Alternative

The slurry line failure and HEPA filters failure inside the proposed treatment facility would result in the same impacts as those calculated for the Low-Temperature Drying Alternative.

4.11.5.4 Cementation Alternative

The slurry line failure and HEPA filters failure inside the proposed treatment facility would result in the same dose and consequence to the surrounding population within 50 miles as those calculated for the Low-Temperature Drying Alternative. The risk increases to 1.6E-04 expected fatalities due to the longer tank waste treatment period of six years. The risks to the public MEI and non-involved worker would be negligible.

4.11.5.5 Treatment and Waste Storage at ORNL Alternative

The slurry line failure and HEPA filters failure inside the proposed treatment facility would result in the same dose and consequence to the surrounding population within 50 miles as those calculated for the Low-Temperature Drying Alternative. The corresponding risk ranges from 7.8E-05 to 1.6E-04 expected fatalities depending on the length of the tank waste treatment period. The risks to the public MEI and non-involved worker would be negligible.

4.11.6 Failure of Contact-Handled or Remote-Handled Solid Waste Containers Before, During, and After Waste Treatment

The failure of contact-handled or remote-handled solid waste containers before, during, and after waste treatment includes several accident scenarios. The contact-handled and remote-handled solids are stored within steel containers and casks in their current storage facilities. The risk of storage is expected to be small because the wastes are not in a dispersible form; they are confined within waste packages. Releases occurring as a result of postulated accidents would be confined within the storage buildings. However, bounding estimates of the frequency categories and consequences of accidents have been made. Three types of accidents were evaluated for the pre-treated wastes stored in the existing waste storage facilities. These include a vehicle impact (e.g. a forklift truck accident), earthquake, and a vehicle impact/fire. During waste treatment, the solid wastes would be sorted and repackaged. Three types of accidents were evaluated that could occur during solid waste treatment: vehicle impact, a vehicle impact/fire, and a processing fire with degraded filters. Following waste treatment, a vehicle impact/fire was evaluated for the alternatives. Pretreatment activities for contact-handled and remote-handled waste are identified for all action alternatives. Waste retrieval and on-site transportation risks are addressed in Section 4.8.

The following assumptions are made to estimate accident consequences:

- The contact-handled wastes have an average concentration of 8.1 Ci/m^3 equivalent plutonium-239, and the remote-handled wastes have an average concentration of 0.62 Ci/m^3equivalent plutonium-239. (An equivalent curie of plutonium-239 is the inhaled activity of the mixture of radionuclides that produces the same radiological dose as the inhaled dose of the mixture of other radionuclides.) These concentrations were calculated based on data in the *TRU Waste Baseline Inventory Report* (1997) (see Appendix B for data summary). However, in all consequence calculations involving these wastes, the bounding concentration of 8.1 Ci/m^3 is used.

- The total volume of contact-handled solid wastes to be processed is 1,000 m^3, and the total remote-handled solid waste volume is 550 m^3.

- For the vehicle impact and earthquake accidents, damage to the affected waste packages is expected, but the waste packages are not completely destroyed. Under these conditions, it is assumed that 10% of the radionuclides are released from the base waste materials as a powder, a fraction of 6E-04 of the powder is suspended as a respirable aerosol, and 10% of the aerosol is released from the waste package(s) (DOE 1994).

- In the event of a postulated local fire (e.g., a forklift accident and ignition of the fuel), 50% of the contents of the waste packages affected are assumed combustible. A bounding estimated fraction of 5E-04 of packaged combustible wastes becomes suspended as a respirable aerosol in a fire.

- None of the released radionuclides is held up in the storage buildings.

- The distance from each waste site to the ORR boundary is assumed to average 1,439 m (4,721 ft), the distance from the Melton Valley Storage Tanks to the ORR boundary (Bechtel Jacobs 1999). Using F-stability conditions and 1 m/s wind velocities, the computed χ/Q is 3.7E-04 s/m^3 (Turner 1969). The χ/Q at the non-involved worker, 80 m from the release, is 4E-02 s/m^3 as previously discussed.

- The inhalation dose to the surrounding population within 80 km (50 miles) is computed based on the airborne pathway model discussed in Section 3 (ORNL et al. 1997).

4.11.6.1 No Action Alternative

Since there would be no treatment under the No Action Alternative, only three accident scenarios are postulated to affect the remote-handled and contact-handled waste packages that would continue to be stored in the existing storage facilities. Due to the expected infrequent vehicle activity, significant vehicle accidents are estimated to occur in the 1E-02 to 1E-04 per year "unlikely" frequency range. The combination of a vehicle accident and a fire reduces the frequency by one category to 1E-04 to 1E-06 per year ("extremely unlikely" frequency range). The evaluation basis earthquake occurs in the 1E-02 to 1E-04 per year category.

A vehicle impact accident (without an assumed fire) is postulated to affect 1% of the contact-handled stored wastes (10 m^3 or four ST-90 boxes). An earthquake (without an assumed fire) is postulated to affect 10% of the stored wastes (155 m^3 or 57 ST-90 boxes). A vehicle impact and fuel ignition accident is postulated to affect the contents of one contact-handled ST-90 box (2.7 m^3 containing 50% combustible wastes). In the vehicle impact/fire accident, 1% of the wastes are also affected due to the mechanical impact. However, due to the noncombustible waste containers, the spread of fire to other containers is not considered likely.

The radiological dose to the public MEI standing on the ORR site boundary in the center of the plume is computed as the product of the respirable source term (Assumptions 1 to 5), a χ/Q of 3.7E-04 s/m^3 (Assumption 6), a breathing rate of 1.2 m^3/h or 3.3E-04 m^3/s (Bechtel Jacobs 1999), and an inhalation dose conversion factor of 5.1E+08 rem/Ci for plutonium-239 (DOE/EH-0071) (DOE 1998a). The estimated source terms and risks for each accident scenario are listed in Tables 4-25 and 4-26, respectively.

Table 4-25. Estimated source terms for the No Action Alternative contact-handled and remote-handled waste storage accidents

Accident	Volume of waste affected (m^3)	Total suspension fraction	Respirable aerosol source term (Ci plutonium-239)
Vehicle impact	10	6E-06	4.9E-04
Earthquake	155	6E-06	5.1E-03
Vehicle impact/fire			
Effect of impact	10	6E-06	4.9E-04
Effect of fire	1	5E-04	4.1E-03
Total source term			4.5E-03

Table 4-26. Estimated frequencies and consequences for the No Action Alternative contact-handled and remote-handled waste storage accidents

Accident	Public MEI site boundary dose (rem)	Population dose (person-rem/ accident)	Consequence (LCF/accident)	Frequency range	Risk to population (expected fatalities)[a]
Vehicle impact	0.031	470	0.24	1E-02 to 1E-04 per year	0.024
Earthquake	0.32	4,900	2.4	1E-02 to 1E-04 per year	0.24
Vehicle impact/ fire	0.28	4,300	2.1	1E-04 to 1E-06 per year	0.0021

[a]The risk computations are based on the midpoint frequency in the frequency range.

Consequences to the surrounding population within 80 km (50 miles) due to airborne releases are estimated as described for the Melton Valley Storage Tanks accidents, based on the pathway modeling and the incidence rate of 5E-04 LCF per person-rem described in Section 3. Consequences to the non-involved worker are based on an incidence rate of 4E-04 cancer fatalities per person rem (ORNL et al. 1997).

The doses to the non-involved worker 80 m from the release point are estimated based on the MEI ORR boundary doses in Table 4-26 and the ratio of the χ/Q values of 108. The non-involved worker doses for the vehicle impact, earthquake, and vehicle impact/fire are 3.3, 35, and 30 rem, respectively.

The risks to the public MEI are 1.6E-06, 1.6E-05, and 1.4E-07 expected fatalities for the three accidents. The corresponding risks to the non-involved worker are 1.4E-04, 1.4E-03, and 1.2E-05 expected fatalities. The risks are based on the midpoint of the annual frequency range over the 100-year period of institutional control.

4.11.6.2 Low-Temperature Drying Alternative

Table 4-27 presents the frequency, consequences, and risks of the various accident scenarios for the Low-Temperature Drying Alternative.

Table 4-27. Frequency and consequences of contact-handled and remote-handled solid waste treatment accidents for the Low-Temperature Drying Alternative

Accident	Frequency range	Public MEI site boundary dose (rem/ accident)	Inhalation population dose (person-rem/ accident)	Consequence (cancer fatalities/ accident)	Risk to population (expected fatalities)[a]
Bounding storage accidents before waste treatment					
Vehicle impact	1E-02 to 1E-04 per year	0.031	470	0.24	7.1 E-04
Earthquake	1E-02 to 1E-04 per year	0.32	4900	2.4	7.2E-03
Vehicle impact/fire	1E-04 to 1E-06 per year	0.28	4300	2.1	6.3E-05
Bounding accidents during waste treatment					
Vehicle impact	1E-02 to 1E-04 per year	<0.001	<15	<0.0075	2.3E-05
Vehicle impact/fire	1E-04 to 1E-06 per year	<0.001	<15	<0.0075	2.3E-05
Processing fire with degraded filters	1E-04 to 1E-06 per year	0.022	340	0.17	5.1E-06
Bounding accidents after waste treatment					
Vehicle impact/fire	1E-04 to 1E-06 per year	0.28	4300	2.1	6.3E-05

[a]The risk computations are based on the midpoint frequency in the frequency range and a treatment time of 3 years.

As shown, the population risks are a factor of 30 smaller than for the No Action Alternative due to much smaller time periods at risk (3 vs. 100 years). The risks to the MEI are 4.7E-08, 4.8E-07, and 4.2E-09 expected fatalities for the three accidents. The corresponding risks to the non-involved worker are 4.0E-06, 4.1E-05, and 3.6E-07 expected fatalities.

Once the solid waste packages are brought into the proposed treatment facility, the consequences of accidents are reduced due to HEPA filtration and elevated release point. Within the facility, the wastes are sorted, repackaged, and macroencapsulated; it is anticipated the waste packages will be placed in storage or shipped. The maximum release and suspension of radionuclides can result from accidents occurring while the wastes are being sorted in an unconfined state. Once the solid wastes are treated and encapsulated, the consequences of non-fire accidents are expected to be decreased by a factor at least 10 to 100 since the macroencapsulants effectively prevent suspension of respirable aerosols. For the vehicle impact/fire accident, a reduction in consequences is expected even with combustible macroencapsulants since the reduced waste surface area prevents self-sustained combustion. For conservatism, however, it is assumed that treated packaged wastes with combustible macroencapsulants have the same consequence as the untreated packaged wastes.

As a bounding case, it is assumed that after contact-handled wastes are removed from their waste package, a fire affecting 2.7 m^3 (95 ft^3) of waste (50% combustible) occurs. It is further assumed that the fire damages all HEPA filters, resulting in a combined efficiency of 99% (1% bypass). For unconfined contaminated cellulose and plastic wastes in a fire, 1% of the contaminants will be suspended. The inhalation dose to the public MEI at the ORR boundary is computed as:

$$\text{Dose} = 2.7\ \text{m}^3 \times 8.11\ \text{curies plutonium-239 equivalent}/\text{m}^3 \times 50\%\ \text{combustible} \times 0.01 \times 0.01 \times 1.2\text{E-04 s/m}^3 \times 3.3\text{E-04 m}^3\text{/s} \times 5.1\text{E+08 rem/Ci} = 0.022\ \text{rem}$$

The corresponding affected population inhalation dose and consequence are 340 person-rem and 0.17 LCF. The likelihood of this accident depends on the probability that a relatively small fire can degrade multiple-series filters to a total estimated efficiency of 99% (from an initial efficiency of more than 99.9% for each filter stage). The frequency of the fire, given the lack of significant ignition sources, is estimated to be in the "unlikely" frequency range (1E-02 to 1E-04 per year). The probability of significant degradation of multiple-filter banks decreases this frequency to the "extremely unlikely" frequency range (1E-04 to 1E-06 per year) or lower.

Due to the elevated release point, the dose to the non-involved worker is the same as for the MEI at the ORR boundary, 0.022 rem. The risks to the MEI and non-involved worker are a factor of a thousand lower than the population risk and are considered negligible.

4.11.6.3 Vitrification Alternative

A drop or impact of the bare solidified glass matrix could result in a very small quantity of suspended respirable-sized particles (DOE 1994). With the metal casing enclosing the matrix, the quantity suspended is negligible. The solidified glass matrix is not combustible or susceptible to suspension due to an external fire. The consequences of this event are negligible. The contact-handled and remote-handled solid waste repackaging processes are comparable to the Low-Temperature Drying Alternative. The principal difference is the use of a noncombustible macroencapsulant (grout) for remote-handled and contact-handled solids in the Vitrification Alternative. This eliminates the small consequence of the vehicle/fire accident involving processed waste packages resulting in negligible consequence and risk after treatment.

4.11.6.4 Cementation Alternative

Similar to the Vitrification Alternative, the consequences of accidents affecting solid waste containers are considered negligible.

4.11.6.5 Treatment and Waste Storage at ORNL Alternative

Similar to the Low-Temperature Drying Alternative, the consequences of accidents affecting solid waste containers during treatment are considered negligible. It is assumed that combustible macroencapsulant is used, so the bounding accident dose to the public MEI at the ORR boundary is 0.28 rem for the vehicle impact/fire accident after waste treatment. This dose is based on the conservative assumption that the release in a fire involving a treated package is the same as the release from an untreated package. The corresponding inhalation dose and consequence to the surrounding population within 50 miles are 4,300 person-rem and 2.1 LCF. For a midpoint frequency of 1E-05 accidents per year, and an assumed risk period of 100 years (based on indefinite waste storage at ORNL), the risk is 2.1E-03 expected fatalities in the surrounding population within 50 miles. The risks to the public MEI and non-involved worker would be 1.4E-07 and 1.2E-05 probabilities of fatalities.

4.11.7 Accidents Unique to An Alternative

4.11.7.1 No Action Alternative

No unique accidents were identified for this alternative with the exception of the breach of the Melton Valley Storage Tanks, which was previously addressed in Section 4.11.2.1.

4.11.7.2 Low-Temperature Drying Alternative

No unique accidents were identified for this alternative.

4.11.7.3 Vitrification Alternative

Loss of Cooling Water to Quench Scrubber

In the event of a complete loss of cooling water, high-temperature melter off-gases (300 to 400°C) would be exhausted through the HEPA filters to the 27-m-high stack. Filter failure is assumed. The following source terms have been estimated to result from the melter off-gas release (the source terms were calculated based on mass balance estimates presented in Appendix B):

Radionuclides: 5.3 curies equivalent plutonium-239 processed over 3 years or
2.0E-04 curies equivalent plutonium-239/per hour

NO_X: 60,000 kg NO_2/3 years or
634 mg NO_2/s

Assuming a 1-hour release/exposure, χ/Q of 1.2E-04 s/m^3, a breathing rate of 3.33E-04 m^3/s (1.2 m^3/h), and a dose conversion factor of 5.1E+08 rem/Ci, the resulting dose to the public MEI at the ORR boundary is:

$$\begin{aligned} \text{Dose} &= 2.0\text{E-04 curies} \times 1.2\text{E-04 s/m}^3 \times 3.3\text{E-04 m}^3\text{/s} \times 5.1\text{E+08 rem/Ci} \\ &= 0.0040 \text{ rem} \end{aligned}$$

The corresponding affected population inhalation dose in the surrounding population within 50 miles is 61 person-rem resulting in 0.031 LCF.

The peak nitrogen dioxide concentration (C) at the ORR site boundary is:

$$\begin{aligned} C &= 700 \text{ mg } NO_2\text{/s} \times 1.2\text{E-04 s/m}^3 \\ &= 0.076 \text{ mg } NO_2\text{/m}^3 \end{aligned}$$

This value is well below continuous exposure limits for NO_2 (1.9 mg/m^3 time-weighted average) and shorter duration exposure limits such as the Emergency Response Planning Guideline–Level 2 (ERPG-2) concentration of 29 mg/m^3.

Since both the radiological contaminants and the NO_2 are released via the 27-m-high stack, the maximum doses to the non-involved worker are the same as the public MEI dose at the ORR boundary.

This accident is estimated to occur in the 1E-02 to 1E-04 per year “unlikely” frequency range depending on the types of controls and interlocks incorporated into the design. Assuming the midpoint frequency of 1E-03 per year, a consequence of 0.031 probability of cancer fatalities, and a risk period of 3 years, the corresponding risk for this accident scenario is 9.3E-05 expected fatalities. The risks to the MEI and non-involved worker are negligible.

Failure of the Melter Exhaust

Failure of the building HEPA filters would not result in any direct release since the hazardous constituents are not suspended in the building air. However, the filters in the melter exhaust path actively filter particulates on a continuous basis. This accident is assumed to occur in the E-02 to

E-04 per year "unlikely" frequency range. The source term at the outlet of the mist eliminators defines the release for this accident:

Source Term = 0.62 curies equivalent plutonium-239/3 years (waste treatment period)
= 2.4E-05 curies equivalent plutonium-239 per hour.

For a 1-hour release, the estimated inhalation dose to the public MEI at the ORR boundary is:

$$\text{Dose} = 2.4\text{E-05 curies} \times 1.2\text{E-04 s/m}^3 \times 3.3\text{E-04 m}^3\text{/s (respiration rate)} \times 5.1\text{E+08 rem/Ci}$$
$$= 4.9\text{E-04 rem.}$$

Since the radionuclides are released via the 27-m (88-ft)-high stack, the maximum dose to the non-involved worker is the same as the MEI dose at the ORR boundary.

The corresponding inhalation dose and consequence in the surrounding population within 50 miles are 7.5 person-rem, and the consequence is 3.8E-03 LCF. The accident is estimated to occur in the 1E-02 to 1E-04 per year "unlikely" frequency range. Based on the midpoint of the frequency range, 1E-03/year and a risk period of three years (based on the tank waste treatment period) the risk is 1.1E-05 expected fatalities. The risks to the public MEI and non-involved worker are negligible.

Release of Molten Waste Glass

Unspecified failures in the melter subsystem could result in a release of molten glass to the treatment facility. The direct hazard of the release is the potential to ignite local fires. This is considered a standard industrial hazard. It is assumed that materials in the vicinity of the melter are noncombustible and a general building fire will not result. In addition, it is assumed that wastes would continue to be fed to the melter and released into the building. It is not expected that significant amounts of NO_2 will be generated, or that the building HEPA filters will fail as a result of the accident. However, the presence of the molten glass and other hot surfaces is estimated to increase the fraction of radionuclides suspended by a factor of 10 over the "Slurry Line Failure within Treatment Facility" accident. The resulting dose to the public MEI at the ORR boundary is:

$$\text{Dose} = 0.003 \text{ rem} \times 10 = 0.03 \text{ rem.}$$

Because the radionuclides are released via the 27-m (88-ft)-high stack, the maximum dose to the non-involved worker is the same as the public MEI dose at the ORR boundary.

The inhalation dose and consequence to the surrounding population within 50 miles are 460 person-rem and 0.23 LCF. This accident is estimated to occur in the 1E-04 to 1E-06 per year "extremely unlikely" frequency range. Using the midpoint of the frequency range1E-05/year, results in a risk to the surrounding population of 6.9E-06 expected fatalities. The risks to the MEI and non-involved worker are negligible.

4.11.7.4 Cementation Alternative

An accident involving catastrophic failure of the centrifuge is postulated. It is assumed that rotating elements within the centrifuge fail and have sufficient energy to penetrate the centrifuge casing. Due to the higher internal fluid pressures, a higher fraction of slurry is suspended as a respirable aerosol in the event of containment failure. A bounding respirable suspension fraction of 2E-03 is applied to this accident, a factor of 20 higher than the factor for low-pressure releases (DOE 1994), resulting in a public MEI dose of 0.06 rem at the ORR boundary. The corresponding inhalation dose and consequence to the surrounding population within 50 miles are 920 person-rem, with a consequence of 0.46 LCF. The potential for catastrophic failure of the centrifuge is estimated to be one frequency category lower than for piping failures, or "extremely unlikely" frequency range (1E-04 to 1E-06 per year). Using the frequency midpoint of 1E-05/year and a 6-year risk period, the risk to the surrounding population is 2.8E-05 expected fatalities.

Since the radionuclides are released via the 27-m (88-ft)-high stack, the maximum dose to the non-involved worker is the same as the public MEI dose at the ORR boundary, 0.06 rem. The risks to the public MEI and non-involved worker are negligible.

4.11.7.5 Treatment and Waste Storage at ORNL Alternative

Unique accidents for this alternative are described in the previous sections, since this alternative would involve waste treatment by either low-temperature drying, vitrification, or cementation.

4.11.8 Industrial Accidents

The risks of industrial accidents in each treatment alternative are computed in terms of expected injuries and expected fatalities. These risks are computed directly from the estimated labor (person-hours) per labor category in each treatment alternative defined in Section 4.13, Socioeconomic Impacts, and DOE estimates of the injuries and fatalities per person-hour (DOE 1999).

4.11.8.1 No Action Alternative

The only expected activity occurring during the No Action Alternative is surveillance requiring approximately 2 full-time equivalents or 4,000 person-hours/year. The DOE injury rate for operations is 3.7/200,000 person-hours, and the fatality rate is 3.4E-03/200,000 person-hours (DOE 1999). Assuming institutional control for 100 years, the No Action Alternative results in industrial risks of 7.4 injuries and 6.8E-03 fatalities.

4.11.8.2 Low-Temperature Drying Alternative

The manpower plan for the Low-Temperature Drying Alternative is shown in Section 4.13, "Socioeconomic Impacts" (Table 4-32). The labor expended during the design phase is principally office work and is not counted toward the industrial accident totals. During construction, treatment, and D&D operations, it is assumed that 10% of the technical labor is spent in the field and counted toward the industrial accident totals.

The DOE injury rate for construction is 6.4/200,000 person-hours (versus 3.7/200,000 for operations). The construction fatality rate for this alternative is the same as operations, 3.4E-03/200,000 person-hours. The weighted total labor (including 10% of technical labor) over the 2-year construction phase and 4-year treatment and D&D phase is 470,000 person-hours. The expected industrial risks for the Low-Temperature Drying Alternative are 11 injuries and 8.0E-03 fatalities.

4.11.8.3 Vitrification Alternative

The manpower plan for the Vitrification Alternative is shown in Section 4.13, "Socioeconomic Impacts" (Table 4-35). The assumptions made to estimate the industrial accident risks have been described in Section 4.11.8.2 for the Low-Temperature Drying Alternative. The weighted total labor over the 2-year construction phase and 5-year processing and D&D phases is 1,400,000 person-hours, approximately three times higher than the Low-Temperature Drying Alternative totals. The expected industrial risks for the Vitrification Alternative are 32 injuries and 0.024 fatalities.

4.11.8.4 Cementation Alternative

The manpower plan for the Cementation Alternative is shown in Section 4.13, "Socioeconomic Impacts" (Table 4-38). The assumptions made to estimate the industrial accident risks have been described in Section 4.11.8.2 for the Low-Temperature Drying Alternative. The weighted total labor over the 2-year construction phase and 8-year processing and D&D phases is 920,000 person-hours, approximately two times higher than the Low-Temperature Drying Alternative totals. The expected industrial risks for the Cementation Alternative are 20 injuries and 0.016 fatalities.

4.11.8.5 Treatment and Waste Storage at ORNL Alternative

The incremental labor required for surveillance and maintenance activities is approximately 4000 person-hours/year, the same as the No Action Alternative. Based on this labor rate, the incremental industrial accident risks for the Treatment and Waste Storage at ORNL Alternative are 0.074 injuries/year and 6.8E-05 fatalities/year. For calculation purposes, it was assumed that storage at ORNL would continue for 100 years resulting in 7.4 injuries and 6.8E-03 fatalities. Adding these incremental risks to the treatment risks of the selected treatment alternative yields the total industrial risks of this alternative. The total injuries range from 18 to 39 and the total fatalities range from 0.015 to 0.031. After loss of institutional control, the breach of the Melton Valley Storage Tanks by an earthquake accident is not applicable because the waste in the tanks would have been treated and put in interim storage.

4.11.9 Summary of Accident Analysis Results

The five alternatives to the proposed action have been analyzed to assess the risks to the public and ETTP populations, the public MEI at the ORR boundary, and the maximally exposed non-involved worker associated with the postulated accidents. The accident consequences and frequencies of each alternative are summarized in Table 4-28.

The risk in total expected fatalities to the surrounding public and ETTP populations has been calculated for each alternative and is summarized in Table 4-29. As shown, the overall risks for the treatment alternatives are comparable. The accident risks calculated for the No Action Alternative are higher than those calculated for the three action alternatives (Low-Temperature Drying, Vitrification, or Cementation). It should be noted that the risk of the No Action Alternative was estimated over 100 years. After loss of institutional control, the Melton Valley Storage Tanks and their secondary containment can be expected to fail, potentially resulting in 11 LCF.

Table 4-30 provides a summary of the maximum consequences and risks to the public MEI on the site boundary and the non-involved worker 80 m (262 ft) or more from the treatment facility and Melton Valley Storage Tanks. These consequences and risks result from inhalation; ingestion consequences are not defined for a public MEI at ETTP.

Table 4-28. Summary of accident consequences and frequencies for the alternatives[a]

Alternative/bounding accident	Accident frequency	Population dose[b] (person-rem)	Consequence (LCF/ accident)
No Action Alternative			
• Earthquake: Melton Valley Storage Tanks and confinement failure	1E-04 per year	ETTP - 31,000 Public - 192,000	108
• Earthquake (stored solid wastes)	1E-02 to 1E-04 per year	4,900	2.4
• Vehicle impact/fire	1E-04 to 1E-06 per year	4,300	2.1
Low-Temperature Drying, Vitrification, and Cementation Alternatives			
• Melton Valley Storage Tanks transfer line failure	1E-02 to 1E-04 per year	ETTP - 12,000 Public - 93,000	52
• Earthquake (stored solid wastes until processed)	1E-02 to 1E-04 per year	4,900	2.4
Treatment and Waste Storage at ORNL Alternative			
• Vehicle impact/fire (following Low-Temperature Drying Alternative only)	1E-04 to 1E-06 per year	4,300	2.1

[a]Accidents listed are those with a risk greater than 1E-03 expected fatalities.
[b]East Tennessee Technology Park ingestion dose and public ingestion dose combined.
LCF = latent cancer fatality.
ORNL = Oak Ridge National Laboratory.

The estimated cancer fatality consequences to individuals are computed as the product of the dose and the cancer fatality rates: 5E-04 cancer fatality /rem to the MEI and 4E-04 cancer fatality/rem to the non-involved worker. The risks are computed the same as the population risks: the product of the accident frequency, the operating period, and the cancer fatality consequence.

Table 4-31 provides a summary of the accident frequencies and consequences for the three treatment alternatives associated with waste treatment.

Table 4-29. Summary of total risks to the surrounding public and ETTP populations for the alternatives

Alternative/bounding accident[c]	Average accident frequency[a] (accidents/year)	Accident consequences (fatalities/accident)	Operating period (years)	Risk[c] (total expected fatalities)
No Action Alternative				
Breach of the Melton Valley Storage Tanks due to an earthquake	1E-04	108	100	1.1
Contact-handled and remote-handled solid waste container accidents				
Vehicle impact	1E-03	0.24	100	0.024
Earthquake	1E-03	2.4	100	0.24
Vehicle impact/fire	1E-05	2.1	100	0.0021
Industrial accidents	[b]	[b]	100	0.007
Low-Temperature Drying Alternative				
Transfer line failure between the Melton Valley Storage Tanks and Proposed treatment facility	1E-03	52	3	0.16
Contact-handled and remote-handled solid waste container accidents				
Earthquake – stored solid wastes prior to processing	1E-03	2.4	3	0.0072
Industrial accidents	[b]	[b]	6	0.008
Vitrification Alternative				
Transfer line failure between the Melton Valley Storage Tanks and Proposed treatment facility	1E-03	52	3	0.16
Contact-handled and remote-handled solid waste container accidents				
Earthquake – stored solid wastes (prior to processing)	1E-03	2.4	3	0.0072
Industrial accidents	[b]	[b]	7	0.024
Cementation Alternative				
Transfer line failure between the Melton Valley Storage Tanks and Proposed treatment facility	1E-03	52	6	0.31
Contact-handled and remote-handled solid waste container accidents				
Earthquake - stored solid wastes (prior to processing)	1E-03	2.4	6	0.014
Industrial accidents	[b]	[b]	10	0.016
Treatment and Waste Storage at ORNL Alternative				
Transfer line failure between the Melton Valley Storage Tanks and Proposed treatment facility	1E-03	52	3-6	0.16 – 0.31
Contact-handled and remote-handled solid waste container accidents				
Earthquake - stored solid wastes (prior to processing)	1E-03	2.4	3-6	0.0072 – 0.014
Vehicle impact/fire-after processing	1E-05	2.1	100	0.0021
Industrial accidents	[b]	[b]	100	0.015 – 0.031

[a]Accident frequencies are midpoint values in the estimated ranges for process accidents.
[b]Individual accident frequencies and fatalities/accident are not defined. The risk is computed as the product of the labor hours over the operating period and the expected fatalities per labor hour.
[c]Accidents with risks <1E-03 expected fatalities are considered negligible and are not listed.
ORNL = Oak Ridge National Laboratory.

Table 4-30. Summary of risks for the public MEI and non-involved worker

Alternative/bounding accident[b]	Average accident frequency[a] (accidents/year)	Operating period (years)	Public MEI: Inhalation dose (rem)	Public MEI: Risk (probability of cancer fatality)	Non-involved worker: Inhalation dose (rem)	Non-involved worker: Risk (probability of cancer fatality)
No Action Alternative						
Breach of the Melton Valley Storage Tanks due to an earthquake	1E-04	100	2.1	1.1E-05	230	9.2E-04
Contact-handled and remote-handled solid waste container accidents						
Vehicle	1E-03	100	0.031	1.6E-06	3.3	1.4E-04
Earthquake	1E-03	100	0.32	1.6E-05	35	1.4E-03
Vehicle impact/fire	1E-05	100	0.28	1.4E-07	30	1.2E-05
Low-Temperature Drying Alternative						
Transfer line failure between the Melton Valley Storage Tanks and Proposed treatment facility	1E-03	3	2.1	3.2E-06	230	2.8E-04
Contact-handled and remote-handled solid waste container accidents						
Earthquake - stored solid wastes prior to processing	1E-03	3	0.32	4.8E-07	35	4.1E-05
Vitrification Alternative						
Transfer line failure between the Melton Valley Storage Tanks and Proposed treatment facility	1E-03	3	2.1	3.2E-06	230	2.8E-04
Contact-handled and remote-handled solid waste container accidents						
Earthquake - stored solid wastes (prior to processing)	1E-03	3	0.32	4.8E-07	35	4.1E-05
Cementation Alternative						
Transfer line failure between the Melton Valley Storage Tanks and Proposed treatment facility	1E-03	6	2.1	6.3E-06	230	5.5E-04
Contact-handled and remote-handled solid waste container accidents						
Earthquake - stored solid wastes (prior to processing)	1E-03	6	0.32	9.6E-07	35	8.3E-05
Treatment and Waste Storage at ORNL Alternative						
Transfer line failure between the Melton Valley Storage Tanks and Proposed treatment facility	1E-03	3-6	2.1	3.2E-06 to 6.3E-06	230	2.8E-04 to 5.5E-04
Contact-handled and remote-handled solid waste container accidents						
Earthquake - stored solid wastes (prior to processing)	1E-03	3-6	0.32	4.8E-07 to 9.6E-07	35	4.1E-05 to 8.3E-05
Vehicle impact/fire-after processing	1E-05	100	0.28	1.4E-07	30	1.2E-05

[a]Accident frequencies are median values in the estimated ranges for process accidents and average fatal accident frequencies (assuming an average number of person/years and 1 fatality/accident) for industrial accidents.

[b]Accidents with population risks <1E-03 expected fatalities are considered negligible and are not listed.

MEI = maximally exposed individual.

ORNL = Oak Ridge National Laboratory.

Table 4-31. Summary of the treatment alternatives accident frequencies and consequences

Accident	Accident frequency range	MEI site boundary dose (rem/ accident)	Population dose (person-rem/ accident)	Accident consequences (LCF/accident)
Low-Temperature Drying Alternative				
Melton Valley Storage Tanks transfer line failure	1E-02 to 1E-04 per year	6.1 - Ingestion 2.1 - Inhalation	ETTP - 12,000 Kingston - 61,000 32,000	4.7 31 16
Slurry line failure within process building	1E-02 to 1E-04 per year	0.003	46	0.023
Solid waste container failure	--	Negligible	Negligible	Negligible
Solid waste container impact/fire	--	Negligible	Negligible	Negligible
Building filtration failure: Building filters plus slurry line failure	1E-04 to 1E-06 per year	0.3	4600	2.3
Vitrification Alternative				
Melton Valley Storage Tanks transfer line failure	1E-02 to 1E-04 per year	6.1 - Ingestion 2.1 - Inhalation	ETTP - 12,000 Kingston - 61,000 32,000	4.7 31 16
Slurry line failure within process building	1E-02 to 1E-04 per year	0.003 rem	46	0.023
Loss of cooling water to quench scrubber	1E-02 to 1E-04 per year	0.004 rem 0.084 mg NO_2/m^3	61	0.031
Release of molten waste glass	1E-04 to 1E-06 per year	0.03 rem	460	0.23
Solid waste container impact	--	Negligible	Negligible	Negligible
Solid waste container impact/fire	--	Negligible	Negligible	Negligible
Building filtration failure: Off-gas flow path Building filters plus slurry line failure	 1E-02 to 1E-04 per year 1E-04 to 1E-06 per year	 5E-04 rem 0.3 rem	 7.5 4,600	 0.0038 2.3
Cementation Alternative				
Melton Valley Storage Tanks transfer line failure	1E-02 to 1E-04 per year	6.1 - Ingestion 2.1 - Inhalation	ETTP - 12,000 Kingston - 61,000 32,000	4.7 31 16
Slurry line failure within process building	1E-02 to 1E-04 per year	0.003 rem	46	0.023
Catastrophic release of slurry from centrifuge	1E-04 to 1E-06 per year	0.06 rem	920	0.46
Solid waste container impact	--	Negligible	Negligible	Negligible
Solid waste container impact/fire	--	Negligible	Negligible	Negligible
Building filtration failure: Building filters plus slurry line failure	1E-04 to 1E-06 per year	0.3	4600	2.3

MEI = maximally exposed individual.
LCF = latent cancer fatality.
ETTP = East Tennessee Technology Park.

4.12 NOISE IMPACTS

This section discusses noise impacts that would result from the implementation and the alternatives.

4.12.1 Methodology

Methods used to determine the noise impacts from each alternative are listed below.

- Determined construction-related noise using noise data collected from a noise survey of the site (Appendix C.4), assuming the noise levels would be comparable to those measured during construction of the Old Melton Valley Road.

- Determined operations-related noise levels.

4.12.2 No Action Alternative

The site would be expected to experience noise ranging from rural to light industrial (50 to 60 dBA Leq).

4.12.3 Low-Temperature Drying Alternative

Construction and operation of the proposed treatment facility, and traffic of construction workers and operations personnel would be comparable to currently noise levels (70 dB during construction, and 50 to 60 dB during operations) due to the road construction near the site. D&D would also result in construction-related noise level increases. However, all these noise impacts are temporary and relatively minor. Noise effects on wildlife would be negligible.

4.12.4 Vitrification Alternative

Noise impacts are expected to be up to 70 dB during construction and D&D activities, and 50 to 60 dB during operations. Noise associated with operations would last 3 years

4.12.5 Cementation Alternative

Noise impacts are expected to be up to 70 dB during construction, and 50 to 60 dB during operations. Noise associated with operations would last 6 years. The Cementation Alternative would result in more traffic noise for a longer period, which is associated with the larger volume of waste shipments off-site.

4.12.6 Treatment and Waste Storage at ORNL Alternative

Noise impacts are expected to be similar to the various treatment alternatives during construction and operations. There would be no off-site transportation-related noise. However, continued storage of the waste on-site would require transportation of the treated wastes within the ORNL boundaries.

4.12.7 Noise Impacts Summary

Noise levels for the No Action Alternative should range from rural to light industrial (50 to 60 daily dBA Leq). For the treatment alternatives, noise levels would be very similar to the noise levels experienced during construction of the Old Melton Valley Road, or 50 to 70 daily dBA Leq. For the

Treatment and Waste Storage at ORNL Alternative, construction noise would be 50 to 70 dBA, with noise in the 50 to 60 dBA range during long-term storage at ORNL.

4.13 SOCIOECONOMIC IMPACTS

Socioeconomic impacts resulting from the implementation of the alternatives are discussed in this section. The socioeconomic impacts analyses assumes that all impacts would occur within the four-county region of influence, which includes Roane, Anderson, Knox, and Loudon counties. This assumption was used to identify the maximum potential socioeconomic impact. The employment and earnings impacts were based on an input-output analysis using the Bureau of Economic Analysis Regional Input-Output Modeling System (RIMS II) (Bureau of Economic Analysis 1999). The RIMS II analysis identifies the indirect employment and earnings effects that result from changes in economic activity through purchases made in the local economy by both the facility and the facility's employees and their dependents (wage and salary expenditures). A more detailed discussion of RIMS II is included in Appendix D. In general, no significant employment or earnings impacts were identified for any of the alternatives; the impacts represented less than 1% of baseline economic activity for all of the alternatives. As a result, fiscal impacts are also assumed to be negligible for all alternatives.

The socioeconomic impacts analyses also assumed that employees for any new facility would come from within the region of influence. Therefore, no significant change in population is anticipated, and no impact on housing, schools, or other infrastructure within the region is expected. Utility usage (electricity and water) is discussed in Section 4.9.

4.13.1 Methodology

Methods used to determine socioeconomic impacts for each alternative are listed below.

- Determined the direct employment based on the manpower plan for the alternative.
- Obtained industry-specific RIMS II multipliers from the Bureau of Economic Analysis for the four-county Region of Influence.
- Determined indirect employment impacts by applying RIMS II input-output multipliers to the direct employment.
- Estimated the direct earnings based on direct employment for each phase of the treatment alternative, and average DOE-related wage in the Region of Influence for the design and operations periods and Tennessee average wage for heavy construction during the construction and D&D periods.
- Determined indirect earnings impacts by applying the RIMS II earning multipliers to direct earnings, and
- Computed the percentage change in employment and earnings impacts with respect to the No Action Alternative.

4.13.2 No Action Alternative

Under the No Action Alternative, there would be no change in economic activity and, therefore, no change in population, housing, infrastructure, or economic environment.

4.13.3 Low-Temperature Drying Alternative

The employment and earnings impacts for the Low-Temperature Drying Alternative for the years 2000 to 2010 are discussed below.

4.13.3.1 Employment

Table 4-32 shows the estimated direct employment associated with the Low-Temperature Drying Alternative. Table 4-33 estimates the total employment impact and compares it to an employment baseline calculated for each year from 2000 to 2010. This alternative would have no significant impact on region of influence employment. Estimated impacts in each year total less than 0.1% of baseline wage and salary employment for the duration of the proposed action. No employment effects would carry over beyond project completion in 2006.

Table 4-32. Manpower plan for the Low-Temperature Drying Alternative[a]

	Design											Construction								Operations												D&D		
	1998			1999				2000				2001				2002				2003				2004				2005				2006		
	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3
Technical	27	35	38	38	38	35	35	35	32	27	27	18	18	18	21	24	23	19	12	12	13	12	13	12	13	13	13	13	13	13	13	13	13	9
Craft/Operators	0	0	0	0	0	0	0	0	0	0	0	4	6	6	14	62	61	56	24	47	63	27	27	63	36	36	36	47	20	8	5	5	0	0
Non-Tech	3	3	3	3	3	3	3	3	3	3	3	11	11	11	11	11	11	17	11	11	12	11	11	12	11	11	11	11	11	11	11	11	8	8
Total	30	38	41	41	41	38	38	38	35	30	30	33	35	35	46	97	95	92	47	70	88	50	51	87	60	60	60	71	44	32	29	29	21	17

[a]Full-time equivalents.

Table 4-33. Estimated region of influence employment impacts by year for the Low-Temperature Drying Alternative

Year	Employment base[a]	Direct employment impact[b]	Indirect employment impact
2000	280,357	33.25	30.9
2001	281,704	37.3	38.0
2002	283,057	82.8	84.4
2003	284,416	64.8	100.3
2004	285,782	66.8	103.4
2005	287,154	44.3	35.2
2006	288,533	16.8	13.4
2007	289,919	0.0	0.0
2008	291,312	0.0	0.0
2009	292,711	0.0	0.0
2010	294,116	0.0	0.0

[a]Based on Tables 3-21 and 3-27. Assumes wage and salary employment grows at the same rate as population and that growth rate is constant from 1996–2000 and 2000–2010.

[b]Annual average full-time equivalents based on quarterly totals in Table 4-32.

4.13.3.2 Earnings

Direct earnings for the Low-Temperature Drying Alternative were based on the direct employment estimates presented in Table 4-32. Table 4-34 shows the estimated direct and indirect earnings associated with the employment figures in Section 4.13.2.1 and compares them with the region-of-influence baseline income for each year. The income calculation uses the conservative assumption that real per capita income remains at the 1996 level in order to determine the maximum potential impact. Any increase in real per capita income during the analysis period would reduce the relative economic impact. As the table shows, there would be no significant impact associated with this alternative. Earnings for all years represent less than 0.1% of income for the region.

Table 4-34. Estimated region of influence earnings impacts by year for the Low-Temperature Drying Alternative

Year	Direct earnings[a] ($000)	Indirect earnings ($000)	Total earnings ($000)	ROI baseline income[b] ($000)	Percent of ROI income
2000	$1,578	$986	$2,563	$11,775,954	0.02%
2001	$1,149	$1,130	$2,279	$11,832,509	0.02%
2002	$2,552	$2,510	$5,062	$11,889,336	0.04%
2003	$3,072	$3,306	$6,378	$11,946,436	0.05%
2004	$3,167	$3,408	$6,575	$12,003,810	0.05%
2005	$1,365	$985	$2,349	$12,061,459	0.02%
2006	$517	$508	$1,025	$12,119,386	0.01%
2007	$0	$0	$0	$12,177,590	0.00%
2008	$0	$0	$0	$12,236,074	0.00%
2009	$0	$0	$0	$12,294,839	0.00%
2010	$0	$0	$0	$12,353,887	0.00%

[a]Based on Table 4-33 and the following assumptions: average U.S. Department of Energy-related wage ($47,445) for Phases I and III; Tennessee average wage for heavy construction ($30,839) for Phases II and IV.

[b]Assumes constant population growth rate from 2000 to 2010 and average per capita income for the region of influence (ROI) in 1996 ($22,982).

4.13.4 Vitrification Alternative

The employment and earnings impacts for Vitrification for the years 2000 to 2010 are discussed below.

4.13.4.1 Employment

Expected direct employment is shown for the Vitrification Alternative in full-time equivalents for each quarter in Table 4-35. Table 4-36 shows the total estimated employment impact and compares it to an employment baseline calculated for each year from 2000 to 2010. This alternative would have no significant impact on region of influence employment. Estimated impacts in each year total less than 0.1% of baseline wage and salary employment for the duration of the alternative. No employment effects would carry over beyond completion of the alternative in 2007.

4.13.4.2 Earnings

Direct earnings for this alternative were based on the direct employment estimates in Table 4-35. Table 4-37 shows the estimated direct and indirect earnings associated with the employment figures in Section 4.13.3.1 and compares them with region-of-influence baseline income for each year. The income calculation uses the conservative assumption that real per capita income remains at the 1996 level in order to determine the maximum potential impact. Any increase in real per capita income during the analysis period would reduce the relative economic impact. As the table shows, there would be no significant impact associated with this alternative. Earnings for all years represent less than 0.2% of income for the region.

4.13.5 Cementation Alternative

The project schedule for the Cementation Alternative is the longest, generating the largest cumulative impact of the alternatives discussed. The employment and earnings impacts for the Cementation Alternative for the years 2000 to 2010 are discussed below.

4.13.5.1 Employment

Table 4-38 shows the estimated direct employment associated with the Cementation Alternative. Table 4-39 estimates the total employment impact and compares it to an employment baseline calculated for each year from 2000 to 2010. This alternative would have no significant impact on region of influence employment. Estimated impacts in each year total less than 0.1% of baseline wage and salary employment for the duration of the alternative. No employment effects would carry over beyond project completion in 2010.

Table 4-35. Manpower plan for the Vitrification Alternative[a]

	Design										Construction								Operations												D&D							
	1998		1999				2000				2001				2002				2003				2004				2005				2006				2007			
	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Technical	52	65	71	71	71	65	65	58	58	52	39	48	58	58	58	48	39	33	49	49	36	36	24	24	22	22	22	22	22	22	22	22	20	20	19	19	17	17
Craft/Operators	0	0	0	0	0	0	0	0	0	0	16	32	96	192	192	192	102	76	103	103	97	97	92	92	92	92	82	82	77	66	50	62	62	50	50	37	37	25
Non-Tech	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	17	17	14	14	14	14	14	14	14	14	17	17	14	14	14	14	14	14	9	9
Total	59	72	78	78	78	72	72	65	65	59	62	87	161	257	257	247	148	116	169	169	147	147	130	130	128	128	118	118	116	105	86	98	96	84	83	70	63	51

[a]Full-time equivalents.

Table 4-36. Estimated region of influence employment impacts by year for the Vitrification Alternative

Year	Employment base[a]	Direct employment impact[b]	Indirect employment impact	Total employment impact	Percent of employment base
1996	286,295				
2000	280,357	62.5	58.2	120.7	0.04
2001	281,704	141.8	144.5	286.2	0.10
2002	283,057	192.0	195.7	387.7	0.14
2003	284,416	158.0	244.7	402.7	0.14
2004	285,782	129.0	199.8	328.8	0.12
2005	287,154	114.3	177.0	291.2	0.10
2006	288,533	91.0	72.3	163.3	0.06
2007	289,919	66.8	53.0	119.8	0.04
2008	291,312				
2009	292,711				
2010	294,116				

[a]Based on Tables 3-21 and 3-27. Assumes wage and salary employment grows at the same rate as population and that growth rate is constant from 1996–2000 and 2000–2010.

[b]Annual average full-time equivalents based on quarterly totals in Table 4-35.

Table 4-37. Estimated region of influence earnings impacts by year for the Vitrification Alternative

Year	Direct earnings[a] ($000)	Indirect earnings ($000)	Total earnings ($000)	ROI baseline income[b] ($000)	Percent of ROI income
2000	$2,966	$1,853	$4,820	$11,775,954	0.04
2001	$4,371	$4,300	$8,672	$11,832,509	0.07
2002	$5,921	$5,825	$11,746	$11,889,336	0.10
2003	$7,496	$8,066	$15,562	$11,946,463	0.13
2004	$6,120	$6,586	$12,706	$12,003,810	0.11
2005	$5,421	$5,833	$11,253	$12,061,459	0.09
2006	$2,806	$2,761	$5,567	$12,119,386	0.05
2007	$2,050	$2,025	$4,083	$12,177,590	0.03
2008	$0	$0	$0	$12,236,074	0.00
2009	$0	$0	$0	$12,294,839	0.00
2010	$0	$0	$0	$12,353,887	0.00

[a]Based on Table 4-36 and the following assumptions: (1) average U.S. Department of Energy-related wage ($47,445) for Phases I and III; and (2) Tennessee average wage for heavy construction ($30,839) for Phases II and IV.

[b]Assumes constant population growth rate from 2000 to 2010 and average per capita income for the region of influence (ROI) in 1996 ($22,982).

Table 4-38. Manpower plan for the Cementation Alternative[a]

	Design										Construction							
	1998		1999				2000				2001				2002			
	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Technical	30	37	41	41	41	41	41	37	37	30	20	22	25	25	22	22	20	17
Craft/Operators	0	0	0	0	0	0	0	0	0	0	8	16	24	48	64	64	54	44
Non-Tech	5	5	5	5	5	5	5	5	5	5	12	12	12	12	12	12	12	12
Total	35	42	46	46	46	46	46	42	42	35	40	50	61	85	98	98	86	73

	Operations											
	2003				2004				2005			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Technical	25	25	18	18	12	12	12	12	12	12	12	12
Craft/Operators	39	39	39	39	39	39	39	58	38	38	38	38
Non-Tech	12	12	12	12	10	10	10	10	10	10	10	10
Total	76	76	69	69	61	61	61	80	60	60	60	60

	Operations											
	2006				2007				2008			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Technical	12	12	12	12	12	12	12	12	12	12	12	12
Craft/Operators	38	38	38	57	38	38	38	38	38	38	26	26
Non-Tech	10	10	10	10	10	10	10	10	10	10	12	12
Total	60	60	60	79	60	60	60	60	60	60	50	50

	D&D							
	2009				2010			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Technical	12	12	9	9	7	7	7	5
Craft/Operators	40	36	27	13	9	4	0	0
Non-Tech	12	12	9	9	7	7	7	5
Total	64	60	45	31	23	18	14	10

[a]Full-time equivalents.

Table 4-39. Estimated region of influence employment impacts by year for the Cementation Alternative

Year	Employment base[a]	Direct employment impact[b]	Indirect employment impact	Total employment impact	Percent of employment base
1996	286,295				
2000	280,357	41.3	38.4	79.6	0.03%
2001	281,704	59.0	60.1	119.1	0.04%
2002	283.057	88.8	90.5	179.2	0.06%
2003	284,416	72.5	112.3	184.8	0.06%
2004	285,782	65.8	101.8	167.6	0.06%
2005	287,154	60.0	92.9	152.9	0.05%
2006	288,533	64.8	100.3	165.0	0.06%
2007	289,919	60.0	92.9	152.9	0.05%
2008	291,312	55.0	85.2	140.2	0.05%
2009	292,711	50.0	39.7	89.7	0.03%
2010	294,116	16.3	12.9	29.2	0.01%

[a]Based on Tables 3-21 and 3-27. Assumes wage and salary employment grows at the same rate as population and that growth rate is constant from 1996–2000 and 2000–2010.

[b]Annual average full-time equivalents based on quarterly totals in Table 4-38.

4.13.5.2 Earnings

Direct earnings for the Cementation Alternative were based on the direct employment estimates presented in Table 4-38. Table 4-40 shows the estimated direct and indirect earnings associated with the employment figures in Section 4.13.5.1 and compares them with baseline income for each year. The income calculation uses the conservative assumption that real per capita income remains at the 1996 level in order to determine the maximum potential impact. Any increase in real per capita income during the analysis period would reduce the relative economic impact. As the table shows, there would be no significant impact associated with this alternative. Earnings for all years represent less than 0.1% of income for the region.

Table 4-40. Estimated region of influence earnings impacts by year for the Cementation Alternative

Year	Direct earnings[a] ($000)	Indirect earnings ($000)	Total earnings ($000)	ROI baseline income[b] ($000)	Percent of ROI income
2000	$1,957	$1,223	$3,180	$11,775,954	0.03
2001	$1,820	$1,790	$3,609	$11,832,509	0.03
2002	$2.737	$2,692	$5,429	$11,889,336	0.05
2003	$3.440	$3.701	$7.141	$11.946.463	0.06
2004	$3,120	$3,357	$6,476	$12,003,810	0.05
2005	$2,847	$3,063	$5,910	$12,061,459	0.05
2006	$3,072	$3,306	$6,378	$12,119,386	0.05
2007	$2,847	$3,063	$5,910	$12,177,590	0.05
2008	$2,609	$2,808	$5,417	$12,236,074	0.04
2009	$1,542	$1,517	$3,059	$12,294,839	0.02
2010	$501	$493	$994	$12,353,887	0.01

[a]Based on Table 4-39 and the following assumptions: (1) average U.S. Department of Energy-related wage ($47,445) for Phases I and III; and (2) Tennessee average wage for heavy construction ($30,839) for Phases II and IV.

[b]Assumes constant population growth rate from 2000 to 2010 and average per capita income for the region of influence (ROI) in 1996 ($22,982).

4.13.6 Treatment and Waste Storage at ORNL Alternative

4.13.6.1 Employment

This alternative would have no significant impact on the region-of-influence employment, which includes Anderson, Roane, Knox, and Loudon counties. Table 4-41 provides the estimated employment impact and compares it to an employment baseline calculated for each year from 2000 to 2010. Table 4-41 provides the estimated direct employment data associated with the Treatment and Waste Storage at ORNL Alternative. The estimated impacts in each year total less than 0.1% of baseline wage and salary employment for the duration of this alternative. This alternative would require continued monitoring activities of the treated waste following the D&D of the proposed treatment facility. The current monitoring requirements associated with the TRU waste slated for treatment at the proposed facility is estimated at 1 to 2 full-time equivalents. It is assumed that the post-treatment monitoring for the waste, which would continue to be stored onsite at ORNL, would have similar monitoring requirements, resulting in no net change in employment following D&D of the proposed treatment facility.

4.13.6.2 Earnings

There would be no significant impact with respect to earnings associated with the Treatment and Waste Storage at ORNL Alternative. The earnings for all years represent less than 0.1% of income for the four county region of influence. The direct earnings for this alternative were based on the estimated direct employment data presented in Table 4-42. Table 4-43 provides information on the estimated direct and indirect earnings associated with the employment figures provided in Table 4-41, and compares them with baseline income for each year. The income calculation uses the conservative assumption that real per capita income remains at the 1996 level in order to determine the maximum potential impact. Any increase in real per capita income during the analysis period would reduce the relative economic impact.

Table 4-41. Estimated employment impacts by year for the Treatment and Waste Storage at ORNL Alternative for the region-of-influence

Year	Employment base[a]	Direct employment impact[b]	Indirect employment impact	Total employment impact	Percent of employment base
2000	280,357	33.25	30.9	64.2	0.02
2001	281,704	37.3	38.0	75.2	0.03
2002	283,057	82.8	84.4	167.1	0.06
2003	284,416	64.8	100.3	165.0	0.06
2004	285,782	66.8	103.4	170.1	0.06
2005	287,154	44.3	35.2	79.4	0.03
2006	288,533	16.8	13.4	30.1	0.01
2007	289,919	0.0	0.0	0.0	0.00
2008	291,312	0.0	0.0	0.0	0.00
2009	292,711	0.0	0.0	0.0	0.00
2010	294,116	0.0	0.0	0.0	0.00

[a]Based on Tables 3-21 and 3-27. Assumes wage and salary employment grows at the same rate as population and that growth rate is constant from 1996–2000 and 2000–2010.

[b]Annual average full-time equivalents based on quarterly totals in Table 4-42.

Table 4-42. Manpower plan for the Treatment and Waste Storage at ORNL Alternative[a]

	Design											Construction							
	1998			1999				2000				2001				2002			
	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Technical	27	35	38	38	38	35	35	35	32	27	27	18	18	18	21	24	23	19	12
Craft/Operators	0	0	0	0	0	0	0	0	0	0	0	4	6	6	14	62	61	56	24
Non-Tech	3	3	3	3	3	3	3	3	3	3	3	11	11	11	11	11	11	17	11
Total	30	38	41	41	41	38	38	38	35	30	30	33	35	35	46	97	95	92	47

	Operations							D&D							
	2003				2004				2005				2006		
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3
Technical	12	13	12	13	12	13	13	13	13	13	13	13	13	13	9
Craft/Operators	47	63	27	27	63	36	36	36	47	20	8	5	5	0	0
Non-Tech	11	12	11	11	12	11	11	11	11	11	11	11	11	8	8
Total	70	88	50	51	87	60	60	60	71	44	32	29	29	21	17

[a]Full-time equivalents.

Table 4-43. Estimated earnings impacts by year for the Treatment and Waste Storage at ORNL Alternative for the region-of-influence

Year	Direct earnings[a] ($000)	Indirect earnings ($000)	Total earnings ($000)	ROI baseline income[b] ($000)	Percent of ROI income
2000	$1,578	$986	$2,563	$11,775,954	0.02
2001	$1,149	$1,130	$2,279	$11,832,509	0.02
2002	$2,552	$2,510	$5,062	$11,889,336	0.04
2003	$3,072	$3,306	$6,378	$11,946,463	0.05
2004	$3,167	$3,408	$6,575	$12,003,810	0.05
2005	$1,365	$985	$2,349	$12,061,459	0.02
2006	$517	$508	$1,025	$12,119,386	0.01
2007	$0	$0	$0	$12,177,590	0.00
2008	$0	$0	$0	$12,236,074	0.00
2009	$0	$0	$0	$12,294,839	0.00
2010	$0	$0	$0	$12,353,887	0.00

ROI = Region of Influence.

[a]Based on Table 4-41 and the following assumptions: (1) average U.S. Department of Energy-related wage ($47,445) for Phases I and III; and (2) Tennessee average wage for heavy construction ($30,839) for Phases II and IV.

[b]Assumes constant population growth rate from 2000 to 2010 and average per capita income for the ROI in 1996 ($22,982).

4.13.7 Summary of Socioeconomic Impacts

For the No Action Alternative there would no change in economic activity. For the treatment alternatives, economic activity in the region-of-influence would increase very slightly (0.1% for the Low-Temperature Drying, and Cementation and Treatment and Waste Storage Alternatives, and 0.2% for the Vitrification Alternative.

4.14 ENVIRONMENTAL JUSTICE

This section describes environmental justice impacts, which involve high and adverse human health or environmental impacts that have a disproportionate effect on minority or low-income populations. Each resource area was evaluated to determine if potential pathways would exist which could affect human populations in general and low-income and/or minority populations in particular. For example, land use impacts of the various alternatives were evaluated for significance and to determine if low-income or minority populations would be disproportionately affected. Likewise, biota (such as deer or fish) contaminated by project-related releases were considered in evaluating the relationship between ecological resources and environmental justice. Human health and accidents would have the largest potential impact on human populations. The other resource areas were insignificant for all alternatives and are not discussed further.

4.14.1 Methodology

Methods used to determine the environmental justice impacts for each alternative are listed below.

- Using the census tract maps and considering any special pathways (e.g. subsistence farming), determined for each resource area whether there would be any potential significant adverse impacts on the minority or low-income populations.

- If there would be any potential significant adverse impacts on the minority or low-income populations, determined if the impacts would be disproportionately high and adverse, when compared to the impacts to the general population.

4.14.2 No Action Alternative

Under the No Action Alternative, there are no significant impacts to low-income or minority populations during normal operations. The largest potential impacts involve human health effects. As discussed in Section 4.10, the maximum potential human health effects under normal operations are too small to constitute a significant impact. As discussed in Section 4.11.2 an accident could result in significant human health impacts to the general population, including low-income or minority populations. However, in all of the accidents evaluated, public exposure would result from either surface water transport or airborne release, and impacts are likely to be the same for minority or low-income populations as for the general public, as discussed below.

The surface water exposure would affect populations south and west of the ORR along the Clinch River. Census tracts in this direction include no minority populations and a mixture of low-income and higher income populations (Figures 4-3 and 4-4); therefore, a disproportionate impact on low-income or minority populations from such a release is unlikely. The airborne release pathway is similarly unlikely to have disproportionate effects on minority/low-income populations. Prevailing winds follow the general topography of the ridges. Daytime winds come from the southwest up the valley, and

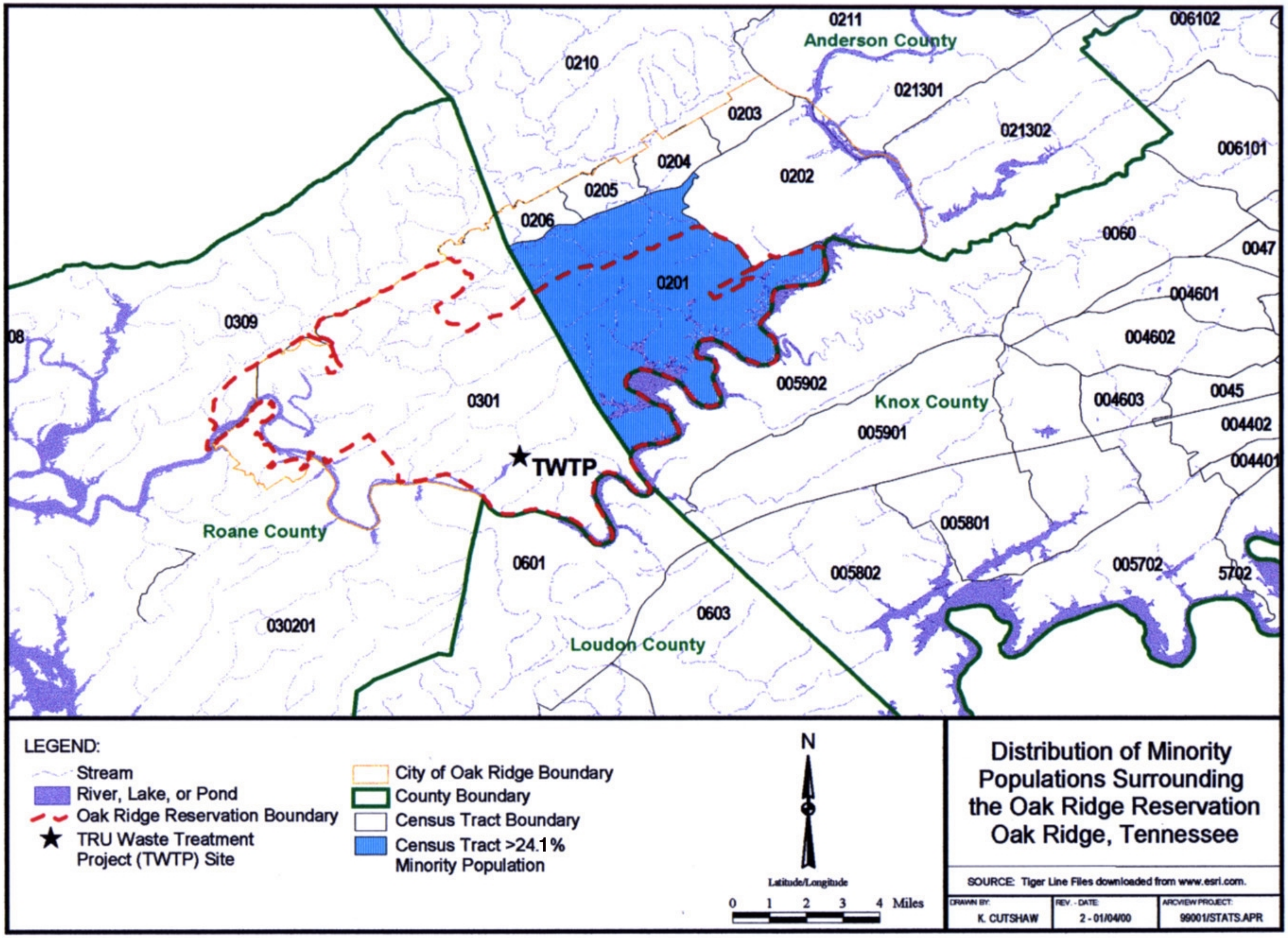

Figure 4-3. Census tracts with a minority population greater than the national average of 24.1%. All residences are restricted to locations outside the ORR boundaries, even though the tract boundaries shown on this map include portions of the ORR.

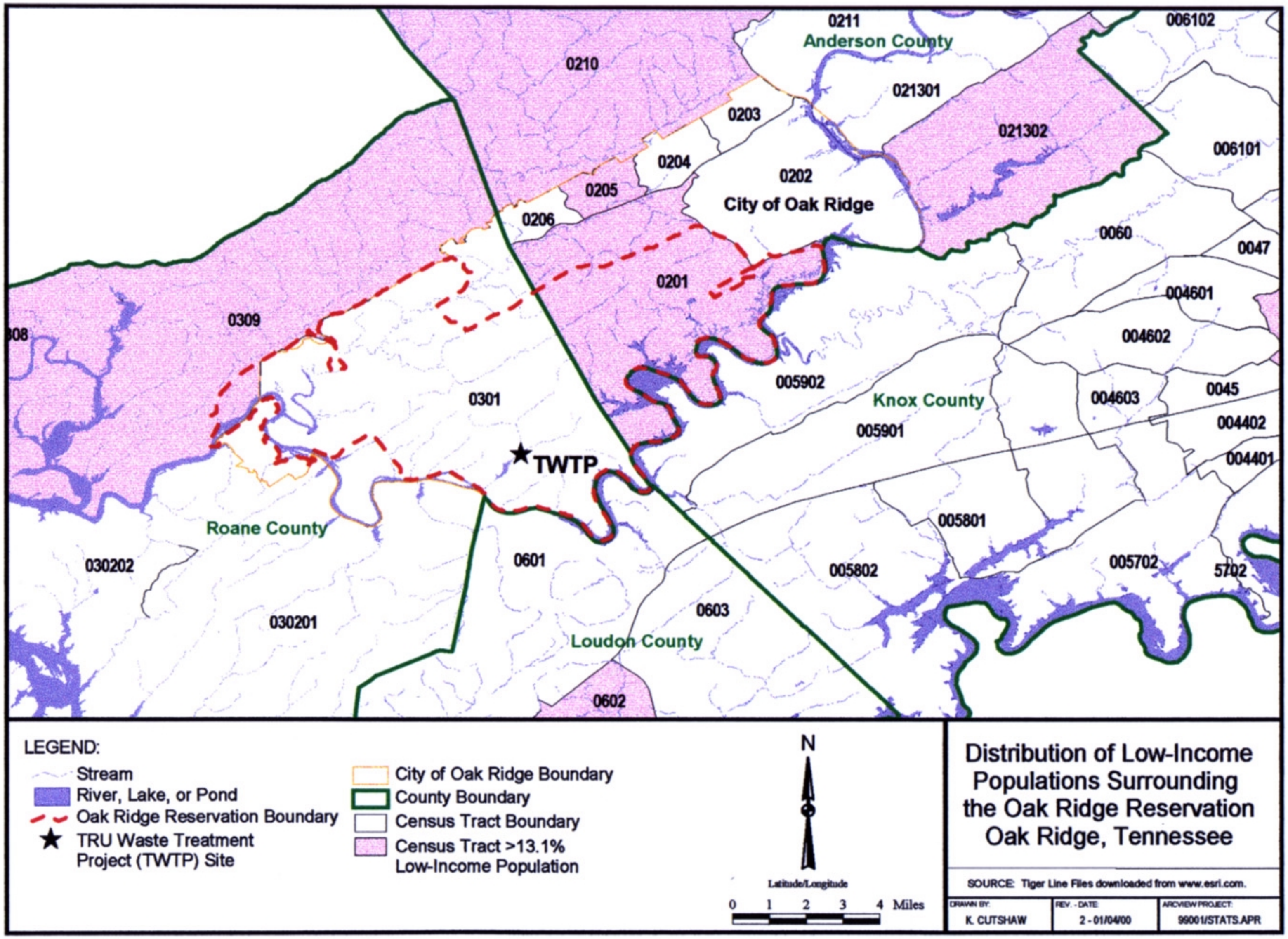

Figure 4-4. Census tracts with a low-income population greater than the national average of 13.1%. All residences are restricted to locations outside the ORR boundaries, even though the tract boundaries shown on this map include portions of the ORR.

nighttime winds come down the valley from the northeast (DOE 1998b, p. 5-36). As in the case of a release via surface water, a nighttime release would affect all populations south and west of the ORR, and would be unlikely to affect minority or low-income populations more than others. A daytime release is likely to have similar effects on both minority and nonminority populations north and east of the ORR. Therefore, even in the unlikely event of an accident, there would be no disproportionately high and adverse impacts on low-income or minority populations.

4.14.3 Low-Temperature Drying Alternative

As in the No Action Alternative, under normal operations environmental impact and risk to low income and minority populations would be minimal. Human health impacts of potential accidents are discussed in Section 4.11.3; in all of the accidents evaluated, public exposure would result from either surface water transport or airborne release. As discussed in Section 4.14.2, release via either of these pathways is unlikely to have disproportionate effects on minority or low-income populations, and therefore no environmental justice impacts would occur.

4.14.4 Vitrification Alternative

As in the No Action Alternative, contaminant emissions and human health impacts under normal operations for the Vitrification Alternative are expected to be minimal. Human health impacts of potential accidents are discussed in Section 4.11.4; in all of the accidents evaluated, public exposure would result from either surface water transport or airborne release. As discussed in Section 4.14.2, release via either of these pathways is unlikely to have disproportionate effects on minority or low-income populations, and therefore no environmental justice impacts would occur.

4.14.5 Cementation Alternative

Contaminant emissions and human health impacts under normal operations for the Cementation Alternative are expected to be minimal. Human health impacts of potential accidents are discussed in Section 4.11.5; in all of the accidents evaluated, public exposure would result from either surface water transport or airborne release. As discussed in Section 4.14.2, release via either of these pathways is unlikely to have disproportionate effects on minority or low-income populations, and therefore no environmental justice impacts would occur.

4.14.6 Treatment and Waste Storage at ORNL Alternative

As in the No Action Alternative, contaminant emissions and human health impacts under normal operations for the Vitrification Alternative are expected to be minimal. Human health impacts of potential accidents are discussed in Section 4.11.6; in all of the accidents evaluated, public exposure would result from either surface water transport or airborne release. As discussed in Section 4.14.2, release via either of these pathways is unlikely to have disproportionate effects on minority or low-income populations, and therefore no environmental justice impacts would occur.

4.14.7 Summary of Environmental Justice Impacts

There would be no disproportionately high and adverse impacts to minority or low-income populations associated with any of the alternatives.

4.15 REFERENCES

Bechtel Jacobs (Bechtel Jacobs Company LLC) 1998. *Radiological Benchmarks for Screening Contaminants of Potential Concern for Effects on Aquatic Biota at the Oak Ridge National Laboratory, Oak Ridge, Tennessee*, BJC/OR-80, Bechtel Jacobs Company LLC, Oak Ridge, Tennessee.

Bechtel Jacobs (Bechtel Jacobs Company LLC) 1999. *Safety Analysis Report for the Liquid Low-Level Waste Management Systems*, WM-LGWO-LLW-SAR, Rev. 0-1, Bechtel Jacobs Company LLC, Oak Ridge, Tennessee, January 26, 1999.

Bureau of Economic Analysis 1999. *RIMS II Multipliers for Eastern Tennessee (Anderson, Knox, Loudon, and Roane Counties)*, Department of Commerce, Bureau of Economic Analysis, May 1999.

Campbell, A. W., G. F. Cada, R. H. Ketelle, R. L. Kroodsma, R. R. Lee, L. R. Pounds. 1989. *Site Characterization Report for the Proposed Transuranic Waste Handling and Packaging Plant*, ORNL/TM-10965, Oak Ridge National Laboratory, Oak Ridge, Tennessee, March.

DOE (U.S. Department of Energy) 1989. *Site Characterization Report for the Proposed Transuranic Waste Handling and Packaging Plant*, Oak Ridge, Tennessee, March 1989.

DOE 1994. *Airborne Release Fractions/Rates and Respirable Fractions for Nonreactor Nuclear Facilities*, DOE-HDBK-3010-94, October 1994.

DOE 1995. *Remedial Investigation Report on Waste Area Grouping 5 at Oak Ridge National Laboratory, Oak Ridge, Tennessee*, DOE/OR/01-1326&D2.

DOE 1997a. *Remedial Investigation Report on the Melton Valley Watershed at Oak Ridge National Laboratory, Oak Ridge, Tennessee: Volume 1. Evaluation, Interpretation, and Data Summary*, DOE/OR/01-1546/V1&D2.

DOE 1997b. *Record of Decision for Interim Action: Sludge Removal from the Gunite and Associated Tanks Operable Unit, Waste Area Grouping 1, Oak Ridge National Laboratory, Oak Ridge, Tennessee*, DOE/OR/OR2-1591&D3, August 1997.

DOE 1997c. *Action Memorandum for the Old Hydrofracture Facility Tanks and Impoundment, Oak Ridge National Laboratory, Oak Ridge, Tennessee*, DOE/OR/01-1751&D3.

DOE 1997d. *Waste Isolation Pilot Plant Disposal Phase Final Supplemental Environmental Impact* Statement, DOE/EIS-0026-S-2, U.S. Department of Energy, Washington, D.C., September 1997.

DOE 1997e. *Final Waste Management Programmatic Environmental Impact Statement for Managing Treatment, Storage, and Disposal of Radioactive and Hazardous Waste*, DOE/EIS-0200-F, U.S. Department of Energy, Washington, D.C., May 1997.

DOE 1998a. *Internal Dose Conversion Factors for Calculation of Dose to the Public*, DOE/EH-0071, July 1998.

DOE 1998b. *Draft Environmental Impact Statement, Construction and Operation of the Spallation Neutron Source Facility*, DOE/EIS-0247, U.S. Department of Energy, Office of Science, December 1998.

DOE 1999. *Advanced Mixed Waste Treatment Project Final Environmental Impact Statement*, DOE/EIS-0290, U.S. Department of Energy, Idaho National Engineering and Environmental Laboratory, Idaho Falls, Idaho, January 1999.

DOE 2000. *Record of Decision for the Department of Energy's Waste Management Program: Treatment and Disposal of Low-Level and Mixed Low-Level Waste; Amendment of the Record of Decision for the Nevada Test Site*, *Federal Register*, Vol. 65, No. 38, 10061–10066, February 25, 2000.

DuVall, G. D. 1992. *An Archaeological Reconnaissance of the Remote-Handled Transuranic Waste Storage Bunker (RH-TRU WSB) and Melton Valley Storage Tank–Capacity Increase Project (MVST-CIP), Oak Ridge Reservation, Anderson and Roane Counties, Tennessee*, prepared for Martin Marietta Energy Systems, Inc., Oak Ridge, Tennessee.

DuVall, G. D. 1993. *An Archeological Reconnaissance and Evaluation of the Oak Ridge National Laboratory, Oak Ridge Reservation, Anderson and Roane Counties, Tennessee*, prepared for Martin Marietta Energy Systems, Inc., Oak Ridge, Tennessee.

DuVall, G. D., and P. A. Souza 1996. *An Evaluation of Previously Recorded and Inventoried Archeological Sites on the Oak Ridge Reservation, Anderson and Roane Counties, Tennessee,* ORNL/M-4946, prepared for Lockheed Martin Energy Systems, Inc., Oak Ridge, Tennessee.

EPA (U.S. Environmental Protection Agency) 1991. *Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual, Supplemental Guidance, Standard Default Exposure Factors, Interim Final*, EPA Office of Emergency and Remedial Response. OSWER DIR: 9285.6-03, Washington, D.C.

EPA 1995. *User's Guide for the Industrial Source Complex (ISC3) Dispersion Models, Volume I: User's Instructions,* EPA-454/B-95-003a, Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina.

Faulkner, C. H. 1988. "Archaeological Investigations of the Jenkins House Site (40RE188) and the Jones House Site (40RE189), Copper Ridge, Oak Ridge Reservation, Roane County, Tennessee," in *Site Characterization Report for the Proposed Transuranic Waste Handling and Packaging Plant, Oak Ridge National Laboratory, Oak Ridge, Tennessee.*

Foster Wheeler (Foster Wheeler Environmental Corporation) 1999. *Required Information for the National Environmental Policy Act for the Treating of Transuranic/Alpha Low-Level Waste at the Oak Ridge National Laboratory, Rev. 1*, Contract No. DE-AC098OR22516, Oak Ridge, Tennessee.

FTH EIS (Fort Huachuca Environmental Impact Statement) 1999. *Final Environmental Impact Statement for the Fort Huachuca Master Plan*, Environmental and Natural Resources Division, Directorate of Installation Support, U.S. Army Garrison, Fort Huachuca, Arizona, May 1999.

Jones, D. 1999. Personal communication between David Jones, Foster Wheeler Corporation, and Wayne Tolbert, Science Applications International Corporation, on October 8, 1999.

Keeler, J. M., J. M. Giaquinto, and A. M. Meeks 1996. *Characterization of the MVST Waste Tanks Located at ORNL,* ORNL/TM-13357, Lockheed Martin Energy Research Corp., Oak Ridge National Laboratory, Oak Ridge, Tennessee.

Kelley, E. 2000. Personal communication from Ed Kelley, Bechtel Jacobs Company LLC with Norm Durfee, Science Applications International Corporation, June 8, 2000.

Moneymaker, R. H. 1981. *Soil Survey of Anderson County, Tennessee*, U.S. Department of Agriculture, Soil Conservation Service in cooperation with Tennessee Agricultural Experiment Station, 165 pp. plus maps.

ORNL (Oak Ridge National Laboratory) 1995a. *Programmatic Environmental Impact Statement Installation Descriptions*, ORNL-6841, Oak Ridge National Laboratory, Oak Ridge, Tennessee, April 1995.

ORNL 1995b. *DOE Public and On-site Population Health Risk Evaluation Methodology for Assessing Risks Associated with Environmental Restoration and Waste Management*, ORNL-6832, Oak Ridge National Laboratory, Oak Ridge, Tennessee, May 1995.

ORNL 1995c. *WM PEIS Methodology for Estimating Human Health Risks Associated with Waste Management*, ORNL-6864, Oak Ridge National Laboratory, Oak Ridge, Tennessee, May 1995.

ORNL et al. (Oak Ridge National Laboratory, Oak Ridge Y-12 Plant, and East Tennessee Technology Park) 1997. *Oak Ridge Reservation Annual Site Environmental Report for 1996*, ES/ESH-73, Oak Ridge, Tennessee, October 1997.

RAIS 2000. *Risk Assessment Information System*, 1/11/2000. Information as located on the world wide web (http:/risk/lsd.ornl.gov/prg/prg_search.html).

Roy, B. 1999. Personal communication between Bryan Roy, Foster Wheeler Environmental Corporation, and Wayne Tolbert, Science Applications International Corporation, on September 13, 1999.

Roy, B. 2000. Personal communication between Bryan Roy, Foster Wheeler Environmental Corporation, and Wayne Tolbert, Science Applications International Corporation, on January 14, 2000.

Saricks, C., and T. Kvitek 1994. *Longitudinal Review of State-Level Accident Statistics for Carriers of Interstate Freight*, ANL/ESD/TM-68, Argonne National Laboratory, Argonne, Illinois. July 1994.

Savannah River Plant 1999. Personal communication between Savannah River Plant Design Group personnel and Robert Garber, Parallax, Inc., in January 1999.

Toy, T. J., and G. R. Foster 1998. *Guidelines for the Use of the Revised Universal Soil Loss Equation (RUSLE), Version 1.06. U.S. on Mined Lands, Construction Sites, and Reclaimed Lands*, Department of Interior, Office of Surface Mining, Denver, Colorado.

Turner, D. Bruce 1969. *Workbook of Atmospheric Dispersion Estimates*, U.S. Department of Health, Education, and Welfare.

THIS PAGE INTENTIONALLY LEFT BLANK